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FEASIBILITY STUDY

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Prepared For:

Waste Management of Illinois, Inc.
Westchester, Illinois

Prepared By

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February 1998

MONTGOMERY WATSON

DRAFT

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Prepared by:	____________________ Thomas S. Tomascik Project Engineer	__________ Date
Approved by:	____________________ Thomas A. Blair, P.E. Project Manager	__________ Date

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1.0 INTRODUCTION

1.1 AUTHORIZATION AND PURPOSE OF REPORT

This Feasibility Study (FS) has been prepared on behalf of Waste Management Illinois, Inc. (WMII), for the H.O.D. Landfill Site (Site) in Antioch, Illinois. This study has been conducted under Administrative Order By Consent (AOC) Docket No. V-W-90-C-71, which was signed on August 20, 1990. The purpose of the FS is to provide information that will assist in the selection of a remedial action alternative that is protective of human health and the environment yet cost effective, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Contingency Plan (NCP). This FS has been prepared in accordance with the U.S. Environmental Protection Agency's (U.S. EPA's) Guidance for Conducting Remedial Investigations and Feasibility Studies for CERCLA Municipal Landfill Sites, using U.S. EPA's "Presumptive Remedy" approach.

The Presumptive Remedy approach is one tool of acceleration within the Superfund program. It recognizes that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or environmental impacts. Presumptive Remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and U.S. EPA's scientific and engineering evaluation of performance data on technology implementation. The Presumptive Remedy for landfills is outlined in OSWER Directive 9355.0-49FS, "Presumptive Remedies for CERCLA Municipal Landfill Sites."

U.S. EPA has established containment as the Presumptive Remedy for landfill sites, based on the volume and heterogeneous nature of the materials deposited at a landfill, and the generally low, long-term threat that may be presented. Primary containment measures include landfill capping, collection and/or treatment of landfill gas (LFG), and control of landfill leachate and affected groundwater, if applicable.

On February 14, 1997, U.S. EPA approved the final remedial investigation (RI) for the Site (Montgomery Watson, January 1997). The data collected and presented in the RI are considered sufficient to evaluate remedial alternatives for the Site. A summary of the RI is presented in Sections 1.3, 1.4 and 1.5 herein. U.S. EPA approved the Baseline Risk Assessment (Baseline RA) on October 29, 1997. A summary of the Baseline RA findings is included in Section 1.6. The approved RI and Baseline RA describe Site conditions that are consistent with continued evaluation as a municipal landfill site.

1.2 REPORT ORGANIZATION

The FS is organized into four sections, as follows:

- Section 1 contains background information for the Site, including a site description and history, a summary of the nature and extent of contaminants identified during the RI, a qualitative discussion of potential contaminant fate and transport, and a summary of the Baseline RA.

- Section 2 summarizes the remedial alternative development process, defines the general site response action objectives and ARARs, and introduces the general response actions.

- Section 3 contains the complete description of the remedial action alternatives developed using the presumptive remedy approach.

- Section 4 contains a detailed evaluation of the remedial action alternatives.

1.3 SITE CHARACTERISTICS

1.3.1 Site Description

The Site is located within the eastern boundary of the Village of Antioch in Lake County in northeastern Illinois (Township 46 North, Range 10 East, SE 1/4, SE 1/4, Section 8 and West 1/2, SW 1/4 of Section 9, Figure 1).

The Site consists of approximately 51 acres of landfilled area out of the total 121.47 acres of property owned by WMII that make up the facility. Although the landfilled area is continuous, it consists of two separate landfill areas, identified as the "old" and the "new" landfills. The "old landfill" consists of 24.2 acres situated on the western third of the property. The "new landfill" consists of 26.8 acres located immediately east of the "old landfill." The two landfill areas have been legally delineated with a division line established under special permit conditions (No. 1975-22-DE and No. 75-329) issued by the Illinois Environmental Protection Agency (IEPA), Division of Land Pollution Control. These Site features are shown on Figure 2.

The landfill cover is continuous across the filled areas of the Site. The landfill cover ranges in thickness from a total of 49 inches to 87 inches based on borings and test pits performed during the RI. Refuse was generally encountered beneath the existing landfill cover. The landfill cover supports a healthy vegetative layer. Since the closure and capping of the Site in 1988, precipitation has resulted in erosional rills and gullies in some areas of the landfill cover. Several areas of differential settlement and stressed vegetation have developed since the cap construction. Minor leachate seeps, animal burrows, and LFG emission areas have also been observed since the cap construction.

LFG is being produced and is currently passively vented through a system of wells at the Site. Although the wells are fitted with flares, the flares are currently not totally effective at controlling the LFG produced. LFG is also migrating horizontally through the unsaturated areas of the subsurface, in the southwest corner of the landfill, and was found to be escaping through some areas of the existing landfill cover. LFG production in a municipal solid waste landfill is typically greatest in the first seven to fifteen years following cap construction, and typically decreases each year thereafter.

The leachate generated by the Site contains constituents typical of municipal landfill leachate. Leachate removal began in 1987. Based upon 1993 records, approximately 450,000 gallons of leachate are removed from the landfill each year. Leachate level measurements are collected at the Site, and indicate that the Site is in compliance with the leachate maintenance levels established by IEPA for the Site.

1.3.2 Physical Characteristics

Climate. The Site is located within a continental climatic belt characterized by frequent variations in temperature, humidity and wind direction. The average daily minimum temperature is 15° F in January and the average daily maximum temperature is 83° F in July. The average annual precipitation is 32.5 inches. The wettest months are April through September (USDA, 1970).

Physiography. The Site is situated within the Valparaiso Morainic System (Willman, 1975). The topography of the area is generally characterized by gentle slopes with poorly defined surface drainage patterns, depressions, and wetlands. The maximum relief in Lake County is 340 feet.

The topography in the vicinity of the Site is generally flat. The most prominent topographic feature in the general area is the landfill. The maximum elevation of the landfill is approximately 800 feet mean sea level (MSL). The elevation of Sequoit Creek is approximately 762 feet MSL. Therefore, maximum ground surface relief at the Site is approximately 40 feet.

Surface Hydrology. Surface drainage around the Site is generally toward the Fox River, located approximately five miles to the west. Locally, surface water flows from the Site toward Sequoit Creek. Sequoit Creek originally flowed northwest from Silver Lake to a point that is now the approximate center and northern boundary of the Site, and then flowed west toward the Village of Antioch. However, sometime between 1964 and 1967, Sequoit Creek was rerouted to flow west from Silver Lake along what is now the southern boundary of the Site. At the southwestern corner of the landfill, the creek was rerouted to flow north along the western boundary of the Site. Approximately 250 feet north of the northwestern corner of the Site, the creek channel turns west and the creek flows approximately two miles before discharging into Lake Marie. Lake Marie eventually discharges to the Fox River.

Wetlands. Based on aerial photographs and a 1960 USGS topographic map of the Site area, the eastern portion of the Site was a wetland area prior to landfill development. P.E. LaMoreaux & Associates, Inc. performed a detailed wetland assessment in 1993 and identified seasonal wetlands within only the low elevation portion of the Site, south of the "new landfill" area (see Figure 3). The wetlands are limited to the areas outside the delineated landfill boundaries. Sequoit Creek flows from Silver Lake by way of two stream channels which eventually join and proceed through the seasonal wetlands.

Floodplain. Floodplain maps developed before the operation of the "new landfill" showed that the existing landfill (the "old landfill") was outside the 100-year floodplain. Based on the established flood elevations of 765 to 767 feet MSL, the "new landfill" area is also above the floodplain elevation (FEMA, 1997). Additional information regarding surface hydrology at the Site can be found in the RI Report.

Surface Soils. The following surface soil types were present at the Site prior to site development, and may still be present in undeveloped areas.

- Houghton muck, wet
- Morley silt loam
- Zurich silt loam
- Peotone silty clay loam
- Peotone silty clay loam, wet
- Mundelein silt loam
- Miami silt loam

The Houghton muck and Peotone silty clay loam are classified by the USDA Soil Conservation Service (SCS) as hydric soils. The Zurich silt loam and Mundelein silt loam are non-hydric soils that may contain hydric inclusions. A description of each soil type is included in the RI Report.

Site Geology. The Site area is underlain by differentiated deposits of sand, gravel, and silty clay. Results of grain size analyses, Atterberg limits testing, TOC analyses, and permeability testing conducted on soil samples during the RI are presented in the RI Report.

The unconsolidated deposits encountered in borings drilled at the Site consist of a depositional sequence of till and outwash deposits associated with the surficial Cahokia alluvium (Holocene) and underlying Wadsworth and Haeger Till Members of the Wedron Formation. The unconsolidated deposits are divided into four distinct depositional units, in order of increasing depth and age:

- **Surface Soils** – Natural surface soils encountered during the RI included 1 to 1.5 feet of reddish to black topsoil formed as the weathered surface of the clay diamict encountered in soil borings. Five feet of peat and organic-rich clay and silts were found overlying the surficial sand in soil borings drilled in the wetland area.

- **Surficial Sand** – The surficial sand is present only along the southern portion of the Site and is not used for public or private water supply. It exhibits an elongated east-northeast to west tending geometry. The surficial sand generally consists of light brown to gray, fine to coarse grained sand, with varying amounts of gravel, silt, and clay. The surficial sand was not encountered in the northern portion of the landfill. A surficial sand isopach map is shown on Figure 17 of the RI Report.

- **Clay-Rich Diamict** – The clay-rich diamict is a laterally extensive deposit which contains various amounts of sand, gravel, and silt mixed in a matrix of clay, which contains discontinuous layers and lenses. The clay-rich diamict is present beneath the entire Site. Based on the soil borings drilled in the vicinity of the Site, the surficial sand is separated from the deep sand and gravel aquifer by the clay-rich diamict. RI data indicate that the clay-rich diamict is typically light to dark gray massive silty to lean clay, with trace to some sand and trace gravel.

- **Deep Sand and Gravel** – The deep sand and gravel is laterally extensive and is present beneath the entire Site. This unit is a part of the regional aquifer and is used regionally as a potable water source. The full thickness of the deep sand and gravel is not known, but the unit is at least 185 feet thick in the general vicinity of the Site. Based on the results of the sieve analysis of the samples collected from the deep sand and gravel from various borings, the upper portion of this unit consists of brown to gray fine to coarse sand, with trace to some gravel, trace to little silt, and trace clay. Lower portions of this unit are poorly sorted and contain greater percentages of gravel.

Geologic cross-sections for the Site are presented in Figures 11 through 16 of the RI Report.

Site Hydrogeology. Three major aquifers underlie the Site. The hydrostratigraphic units of concern include the surficial sand, the underlying clay-rich diamict aquitard and the deep sand and gravel.

Slug tests were performed on monitoring wells during the RI to estimate hydraulic conductivity. Resultant hydraulic conductivity estimates, and the conductivity test results obtained from the previous investigations, are presented in the RI Report. Descriptions of the three major geologic units in the vicinity of the Site follow:

- **Surficial Sand** – Water level elevations obtained from the water table wells and standpipes screened in the surficial sand indicate that the water table is near the surface and that the groundwater in the surficial sand is flowing into Sequoit Creek under a shallow hydraulic gradient. The rate of horizontal and vertical groundwater flow in the surficial sand is controlled by the hydraulic gradient and the hydraulic conductivity of the surficial sand. The results of the single well hydraulic conductivity slug tests performed in the surficial sand wells indicate horizontal hydraulic conductivity of the surficial sand ranges from 2.10×10^{-2} to 3.60×10^{-4} centimeters per second (cm/s). Based on the water level elevations obtained from well nests at the Site in June 1993, a very slight downward vertical hydraulic gradient of 0.002 foot per foot was observed from the water table surface to the base of the surficial sand.

- **Clay-Rich Diamict** – The clay-rich diamict acts as an aquitard, separating the surficial sand from the deep sand and gravel. Groundwater movement within the clay-rich diamict is greatly restricted, and primarily downward. The rate of groundwater movement within the diamict is controlled by the hydraulic conductivity of the diamict and the hydraulic gradient across the diamict. The results obtained from the single well hydraulic conductivity slug tests performed in wells screened in the clay diamict indicate horizontal hydraulic conductivity of 7.9×10^{-6} cm/s in one piezometer and 8.0×10^{-6} cm/s in another piezometer. During the RI, laboratory constant head permeability tests results indicated that the vertical and horizontal hydraulic conductivities of the clay-rich diamict are low, and as a result, poor hydraulic communication exists between the surficial sand and the deep sand and gravel. The properties of this soil layer were the basis for IEPA's approval of this site as a suitable location for a solid waste landfill.

- **Deep Sand and Gravel** – The deep sand and gravel aquifer is used for public water supply by the Village of Antioch, and for private well use at nearby residences located east (hydraulically upgradient) of the Site. This deep sand and gravel aquifer occurs beneath the entire Site, based on soil borings drilled during the previous site investigations and the RI. Based on the piezometric head elevation data collected in 1993 and 1994, the groundwater within the deep sand and gravel appears to be flowing from northeast to southwest under a low hydraulic gradient.

1.3.3 Site History

Ownership. Permitted waste disposal activities began at the Site in 1963 and continued through site closure in 1984. The Site has been owned and/or operated by three distinct companies:

- Cunningham Cartage and Disposal Company (1963 - 1965)
- H.O.D. Disposal, Inc. (1965 - 1972)
- C.C.D. Disposal, Inc. (1972 - present, including merger with WMII).

Murrill Cunningham, owner, operator, and president of Cunningham Cartage and Disposal Company operated a 20-acre landfill (the "old landfill" area) at the Site from 1963 until August 1965. The property was then purchased by John Horak and Charles Dishinger, who operated the Site under the name H.O.D. Disposal, Inc. In December 1972, the 20-acre landfill was conveyed to C.C.D. Disposal, Inc. and C.C.D. Disposal, Inc. purchased the adjacent 60-acres of land to the east of the Site. WMII merged with H.O.D. Disposal, Inc. and C.C.D. Disposal, Inc., gaining ownership of the Site. A small portion of the Site is currently owned by the Village of Antioch. WMII operated the landfill from 1973 until 1984 when the Site was closed. During the time WMII operated the landfill, portions of the 60-acre property (the "new landfill" area) were opened for landfilling.

History of Regulatory Agency Response Actions. In June 1981, WMII submitted to the U.S. EPA a Hazardous Waste Site Notification form, as required by Section 103(c) of CERCLA. The form indicated solvents, heavy metals, and cutting and hydraulic oils may have been disposed of at the Site, in addition to municipal waste.

The U.S. EPA conducted a Preliminary Assessment in 1983, a Site Inspection in 1984, and an Expanded Site Inspection between 1986 and 1989. During that period (1988), the Site was closed, and a landfill cover, leachate wells and LFG vents were installed in accordance with the applicable regulations in force at the time. The Site was placed on the National Priorities List (NPL) on February 21, 1990, based on an HRS score of 34.68 (out of 100), which was above U.S. EPA's eligibility threshold limit of 28.5 for Sites to be proposed for the NPL. The U.S. EPA identified a number of potentially responsible parties (PRPs); however, only WMII agreed to participate in the RI/FS. An Administrative Order on Consent (AOC) was signed between U.S. EPA and WMII in August, 1990.

In May 1990, WMII retained Montgomery Watson (formerly Warzyn) to support WMII's RI/FS effort by preparing the Work Plan for Preliminary Site Evaluation Report/Technical Scope (PSER/TS) and to subsequently perform the RI. The RI was conducted in 1993 and 1994. The final RI Report was approved by the U.S. EPA and IEPA on February 14, 1997. The draft Baseline RA was submitted by ICF Kaiser in 1994. WMII received comments on the Baseline RA from the IEPA in December 1996, and the U.S. EPA in February 1997. WMII addressed the comments to the Baseline RA which was finalized and approved on October 29, 1997.

Previous Site Investigations. Several investigations have been conducted at the Site and are listed below in approximate chronological order. Additional details, and the results of the investigations, are described in the RI Report.

- In 1965, prior to drilling and constructing Village Well 4, three test holes (1-65, 2-65 and 3-65) were drilled (to identify adequate thickness of water bearing units) in the Sequoit Acres Industrial Park area.

- A soil investigation was conducted by Testing Services Corporation (TSC) in 1973 to assess conditions for the expansion of the landfill and the construction of an on-site maintenance building.

- TSC installed six groundwater monitoring wells for WMII in May 1974.

- A hydrogeologic report for the proposed landfill expansion to the north was prepared in 1982.

- IEPA prepared a trend analysis report summarizing the analytical data collected between November 1974 and December 1981 from the six on-site monitoring wells.

- A Preliminary Assessment (PA) was completed on February 11, 1983 by the field investigation team (FIT) at the request of the U.S. EPA. The PA identified several data gaps including determination of waste quantity and information related to possible groundwater or surface water contamination.

- A Site Inspection was conducted on July 10, 1984 by the FIT. Groundwater samples were collected from on-Site monitoring wells. Analysis of groundwater samples, particularly from well G103, reportedly revealed the presence of elevated concentrations of zinc, lead, and cadmium. Analysis of surface water samples did not reveal elevated levels of analyzed parameters.

- Dames and Moore conducted a hydrogeologic assessment of the Site in 1985 at the request of WMII.

- In January 1986, IEPA collected groundwater samples from four residential wells located east of the Site. The samples were analyzed for nitrates, organic compounds and trace metals. The results of the chemical analysis indicated no trace metals and no organic compounds were detected.

- An Expanded Site Investigation (ESI) was conducted by the FIT (Ecology and Environment, 1989) during the period 1987 through 1989.

- Between 1989 and July 1990, P.E. LaMoreaux & Associates, Inc. (PELA), on behalf of WMII, conducted various site investigations.

- Video camera logging of Village Well 4 was conducted by PELA. Some areas of the well appeared to be badly pitted.

- Patrick Engineering, Inc. (Patrick) prepared an Environmental Audit of Sequoit Acres Industrial Park in 1989 on behalf of WMII. Patrick concluded that several potential sources of soil and/or groundwater contamination existed in the Sequoit Acres Industrial Park, including industry and landfilled areas containing both fill and refuse.

- Shallow borings were drilled at three locations in October 1989 by Patrick for Geoservices Inc. of Boynton Beach, Florida to collect samples of the clay diamict for laboratory permeability testing. Hydraulic conductivity values for the clay soils ranged from 2.1x10-7 cm/sec to 9x10-9 cm/sec. Results of the permeability testing of the clay diamict soils are summarized in Table 5 of the PSER/TS.

- Five temporary leachate piezometers were installed at the "old landfill" for WMII by Stratigraphics, Inc. on July 24 and 25, 1990. Leachate samples were collected for laboratory analysis from temporary leachate piezometers in July and August 1990. The Stratigraphics report indicated clay underlies refuse at each of the temporary leachate piezometer locations. Leachate samples were collected for laboratory analysis from temporary leachate piezometers TLP1 through TLP4 on July 27, 1990. Samples were collected from TLP2, TLP4, and TLP5 on August 10, 1990. Samples were analyzed for organics, metals and indicator parameters. Low levels of VOCs (primarily alkenes and aromatics) were detected in each of the leachate samples. Few detections of SVOCs were noted in the leachate samples, with naphthalene being the most commonly detected of the SVOCs.

- A Hydropunch groundwater sample was collected near monitoring well US4S in May 1990. The sample was collected from a fine to medium sand at a depth of 20 to 21 feet below ground surface and was submitted for VOC analysis. VOCs detected in the groundwater sample included cis-1,2-DCE (110.3 ug/L), trans-1,2-DCE (1.4 ug/L), methylene chloride (2.7 ug/L) and vinyl chloride (188.4 ug/L).

- Groundwater quality samples were collected by WMII at ten on-site monitoring wells on July 1990. Samples were analyzed for organics, metals and groundwater quality indicator parameters. Analytical results indicates that VOCs were only detected in samples collected from wells US4S (cis-1,2-DCE @ 39.7 ug/L; trans-1,2-DCE @ 1.8 ug/L), US6D (TCE @ 0.7 ug/L) and R103 (cis-1,2-DCE @ 0.5 ug/L; TCE @ 4 ug/L).

- Eight leachate samples were collected from the "new landfill" and from the "old landfill" in June 1990 and were analyzed for organics.

- The U.S. Geological Survey (USGS), in cooperation with the U.S. EPA, performed an evaluation of the aquifer pump test data collected during the ESI Report and presented the results in a report titled "Determination of Hydraulic Properties in the Vicinity of a Landfill Near Antioch, Illinois" (USGS, 1990).

1.3.4 Local Demography and Land Use

The Site is bordered on the south and west by Sequoit Creek. Silver Lake is located approximately 200 feet southeast of the Site. The Silver Lake residential subdivision is located east of the Site and agricultural land, scattered residential areas, and undeveloped land are located to the north. A large wetland area extends south of the Site from Sequoit Creek. A large industrial park area (Sequoit Acres Industrial Park), which was constructed on former landfill and fill areas, is located west of the Site and borders Sequoit Creek.

Sequoit Acres Industrial Park includes at least six companies designated as small quantity hazardous waste producers, five registered underground storage tanks ranging in size from

60 gallons to 200,000 gallons, and fill areas that were, at least in part, waste dumps (Cunningham Dump and Quaker Dump). Companies designated as small quantity hazardous waste producers include:

- Quaker Industries
- Chicago Ink and Research Company, Inc.
- Galdine Electronics, Inc.
- Major Industrial Truck, Inc.
- Nu-Way Speaker Products, Inc.
- Roll Foil Laminating, Inc.

Patrick has investigated the development and environmental history of the Sequoit Acres Industrial Park (Patrick, 1989).

Water Supply and Groundwater Use. The Village of Antioch obtains its water from six water supply wells screened in the deep sand and gravel. Under normal operating conditions, the Village wells are automatically activated in alternating cycles when the water pressure from aboveground water storage tanks drops below a designated level. The Village wells are located west and southwest of the Site. The closest Village well, VW4, was taken out of service and replaced with a new village well, VW7, in June, 1997. The location of VW7 is shown on Figure 6.

Privately owned wells in the vicinity of the Site (i.e., Silver Lake residential subdivision) are either screened in the same deep sand and gravel used by the Village of Antioch, or the deeper underlying dolomite. These private wells are located hydraulically upgradient from the Site. These wells are finished at depths ranging from approximately 85 to 250 feet. Household wastewater from the Silver Lake subdivision (east of the Site) is discharged to septic systems.

1.4 NATURE AND EXTENT OF CONTAMINATION

The following media were sampled during the RI: groundwater (from Site and nearby monitoring wells, Village wells, and private wells), leachate, landfill gas, surface water, sediments, and surface soils. A monitoring well and piezometer location map is included as Figure 3. Leachate piezometer and gas probe locations are shown on Figure 4. Figure 5 shows surface water, sediment, and surface soil sampling locations. The Village of Antioch and private water supply well sampling locations are presented in Figures 6 and 7, respectively. Tables 1-1 through 1-7 present summaries of analytical results for sampling conducted during the RI. Table 1-8, a summary of historical monitoring well Volatile Organic Compound (VOC) data, has also been included. Based on this sampling and analysis, VOCs are potential contaminants of concern at the Site.

1.4.1 Surficial Sand

The groundwater samples collected from wells screened in the surficial sand immediately adjacent to the "old landfill" area in which VOCs were detected were found to only contain relatively low concentrations of alkenes and carbon disulfide. (Carbon disulfide was detected during the RI in the Round 1 and Round 2 samples collected from well G11S at concentrations of 0.8J ug/l and 18 ug/l, respectively. 1,2-Dichloroethene was detected during the RI in the Round 1 and Round 2 samples collected from well US4S at concentrations of 35 ug/l and 44 ug/l, respectively.) This suggests that contaminants potentially migrating from the landfill are being attenuated by dilution, adsorption, and/or biodegradation such that entire groups are not detected in these groundwater samples.

VOCs were not detected in the surficial sand wells located on the west or south sides of Sequoit Creek during either of the two rounds of groundwater samples obtained as part of the RI. This indicates that shallow groundwater quality to the west and south of the Site has not been impacted.

1.4.2 Clay Diamict

Trichloroethene (TCE) was detected in one groundwater monitoring well (US6I) which is located in the clay diamict at the southeast corner of the "old landfill" area. The TCE concentrations in groundwater samples collected from that monitoring well since 1987 exhibit a decreasing trend.

1.4.3 Deep Sand and Gravel

VOCs were not detected in the on-site deep sand and gravel wells, indicating that downward migration of VOCs from the surficial sand through the clay diamict does not appear to be occurring. The differences in the hydraulic heads from the surficial sand and the deep sand and gravel also indicate that the clay diamict is continuous and provides resistance to downward vertical flow (i.e., low hydraulic conductivity). Current data are not conclusive as to the source of the VOCs detected in two off-site deep sand and gravel wells.

VOCs (vinyl chloride and 1,2-dichloroethene) were only detected in groundwater samples from one deep sand and gravel monitoring well (US3D), which is located off-site in the industrial park to the west. VOCs (vinyl chloride, acetone and 1,2-dichloroethene) were also detected in only one water supply well, Village Well 4 (VW4), which was the closest Village well to the Site. It should be noted that Vinyl Chloride in VW4 was last detected on August 23, 1989, at 0.2 μg/L, and has not been detected in 24 samples collected from this well since. As mentioned previously, VW4 has been taken out of service, and replaced with VW7.

The detection and potential origin of the VOCs at VW4 (within the deep sand and gravel aquifer) has been intensely studied. The results of the investigations were not conclusive. VW4 was apparently installed in 1965 and apparently constructed through the refuse material of the Cunningham Dump. In addition, as noted earlier, several small quantity hazardous waste generators are located in the industrial park, and may be the source of this deep sand and gravel groundwater contamination. Therefore, the former Cunningham/Quaker Village Dump or the industrial park may be associated with the VOCs found in US3D and VW4.

Although VOCs were detected in the on-site surficial sand wells, they were not present in the on-site deep sand and gravel wells, indicating that downward migration of VOCs from the surficial sand through the clay diamict does not appear to be occurring. The differences in the hydraulic heads from the surficial sand and the deep sand and gravel also indicate that the clay diamict is continuous and provides resistance to downward vertical flow (i.e., low vertical hydraulic conductivity).

1.4.4 Sequoit Creek Surface Water Results

VOCs (2-Hexanone and 4-methyl-2-pentanone) were detected in only one surface water sample which was collected from Sequoit Creek during Round 1. This sample was collected adjacent to the northwest corner of the landfill. No other VOCs, SVOCs or Pesticides/PCBs were detected in any of the other Round 1 or Round 2 samples.

The concentrations of inorganic constituents detected in the surface water samples are much lower than the concentrations detected in the leachate samples. Results presented in the RI indicate that Site leachate has not had a detectable effect on Sequoit Creek surface water quality.

1.4.5 Sequoit Creek Sediment Results

No VOCs or pesticides/PCBs were detected in the sediment samples collected from the creek. The SVOCs that were detected consisted only of PNAs, with the exception of bis(2-ethylhexyl) phthalate, which is a common laboratory contaminant. The PNAs could be due to other industrial sources, as they are common to urban industrial areas. The presence of SVOCs has not been confirmed to be associated with the Site, and may be due to either on-site or off-site sources (i.e., the fill areas of unknown composition located directly west of the north-south leg of Sequoit Creek).

1.4.6 Surface Soils Results

Surface soil samples during the Round 1 sampling activities were collected from areas exhibiting discolored soils, leachate seeps, stressed vegetation, or standing water. These locations were chosen as "worst case" samples in order to document the potential effects of the Site's LFG and leachate on the shallow surface soils of the Site.

The analytical results generally indicate that concentrations of VOCs (primarily aromatics and methylene chloride/acetone) and SVOCs (primarily phthalates and PNAs) are present, in areas with visible evidence of potential impact. No VOCs, and few SVOCs, were detected in a sample collected from an off-site location north of the "new landfill" in an area of standing water and apparent stressed vegetation. Similarly, fewer VOCs and SVOCs were detected off-site in a sample collected from a wetland area near the southeast corner of the "old landfill" and a sample collected from the wetland area east of the "new landfill." Based on these analytical results, it is apparent that leachate and LFG seepage at the Site has only minimally impacted (primarily VOCs and SVOCs) the surficial soils in isolated areas on the landfill cap. Therefore, soils in the landfill cap seem to be effective in preventing the migration of these leachate and LFG seeps.

1.5 CONTAMINANT FATE AND TRANSPORT

While a quantitative evaluation and modeling of fate and transport potential is beyond the scope of this FS, some general statements can be made based upon observed site conditions, known chemical properties, and calculated retardation factors presented in the RI. This section identifies potential migration pathways, briefly describes associated attenuation mechanisms, and describes the fate and transport of specific contaminants found in various media and in the immediate vicinity of the Site.

1.5.1 Primary Transport Pathways of Contaminants of Concern

Migration pathways are defined as routes along which contaminants migrating out of, and away from, a contaminant source (e.g., landfill leachate, LFG) travel towards groundwater, surface soil, surface water, and sediments. The primary vehicle for mobilization of VOCs is partitioning of contaminants from LFG into the leachate and interstitial water in the waste. The primary transport mechanism from the source areas is via LFG, leachate, or groundwater migration.

LFG generation in the reducing environment of the landfill is largely the byproduct of anaerobic decomposition of the refuse. Gas pressure within the landfill builds and gas migrates away from the waste mass through the path of least resistance. Passive gas flares have been installed in the landfill to vent and burn off this gas but are not totally effective. Therefore, some LFG appears to be migrating horizontally and vertically through the surface soils in some locations.

Leachate is produced through the solution and suspension of chemicals mobilized by the interaction of the interstitial water with the waste mass and LFG. The water necessary for the formation of leachate may enter the landfill interior in the following ways: 1) stormwater infiltration through the cover, 2) groundwater seepage through the subsurface, and 3) moisture present within the waste at the time of placement within the landfill.

Leachate may migrate out of the landfill in the following ways:

- Release and transport by groundwater.
- Release directly to surface water and sediments.
- Release through the landfill cover and potential release to the surface soils, surface water and sediments.

1.5.2 Attenuating Effects

The potential chemicals of concern at the Site are mobilized primarily by the interstitial water passing through the waste and dissolving chemicals which forms leachate and chemicals in LFG partitioning into the leachate. This leachate may then migrate from the landfill to affect potential receptors.

The landfill itself functions as a bioreactor, where the organic substrate (the organic fraction of the waste mass), in the presence of moisture, produces an anoxic (reducing) environment which degrades organic compounds and stabilizes the waste mass. This reaction produces LFG, which is primarily a combination of methane and carbon dioxide, with trace concentrations of VOCs.

The potential transport of the chemicals of concern to groundwater is minimized by the low permeability clay underlying the entire Site, and by the organic materials and peat underlying areas of the southern portion of the "old landfill." These low permeability clay materials have a high capacity to adsorb the potential chemicals of concern as do the organic materials and peat, thereby helping to significantly reduce the concentrations of chemicals entering the groundwater. Further attenuation occurs by mixing, adsorption/desorption, biodegradation, oxidation and reduction reactions, precipitation, and volatilization as groundwater moves away from the landfill.

1.5.3 Fate and Migration of Site Contaminants in the Subsurface Landfill Gases. Once generated, LFG migrates from areas of high gas pressure to areas of low pressure (above the fluid levels in the landfill) and is flared (combusted) or emitted to the ambient air via the following release pathways:

- Leachate piezometer/gas wells
- Unlit gas flares
- Fissures in the landfill cover.

The ensuing dilution of the gas in the air is affected by wind speed, turbulence, temperature, height of the release point above the surrounding area, the roughness of the surrounding area, and by decomposition through direct photolysis.

Some LFG chemical constituents commonly partition into the soil (including the landfill cap) or vadose zone interstitial soil water. The infiltration of this vadose zone water presents a potential transport pathway for LFG chemical constituents to enter the leachate and eventually the surficial sand aquifer. This mechanism can contribute to leachate and/or groundwater contamination.

Organic Compounds in Leachate. Leachate samples collected from the Site contained a variety of chemical compound groupings, including chlorinated alkanes and alkenes, ketones, aromatics, phenols, phthalates, PNAs, and PCBs.

The biodegradation of refuse (waste) materials in a reducing environment produces various chemical degradation compounds in the leachate. The biodegradation process may consume much of the organic contaminant mass and produce ammonia, methane, CO_2 and other anaerobic biodegradation and abiotic intermediate and end products. These compounds are detected in the landfill leachate and gas, and indicate that a high level of anaerobic biodegradation is occurring.

Storm water percolating vertically through the landfill cap into the waste mass and groundwater flowing horizontally into the waste mass provides the transport and mixing vehicle that promotes anaerobic biological and abiotic degradation of the chemical compounds. During this process, some of the compounds and degradation products remain or are introduced into the liquid leachate, while other compounds partition into the gas phase. The chlorinated alkenes and alkanes which were detected in the leachate tend to biodegrade more readily under the reducing conditions present in the landfill.

Leachate may migrate from the waste mass into the surrounding subsurface soils or groundwater, or may enter the ambient environment via surface seeps as described at the end of this section. As leachate moves from the waste mass, conditions become less anaerobic (i.e., less reducing), providing an environment more favorable to aerobic degraders. It is under these conditions that the phenols, ketones, aromatics, and to a lesser degree the PNAs and phthalates will be more readily biodegraded.

In addition to biodegradation, adsorption occurs in both the waste mass and in the subsurface environment as leachate moves through the system. Adsorption is a significant attenuation mechanism for the relatively less-soluble and less-degradable leachate constituents such as the PNAs, phthalates, and PCBs. Leachate from the landfill can mix with, and be transported by, groundwater wherein dilution and groundwater attenuation processes may also influence contaminant concentrations.

In addition to subsurface movement, a leachate seep was observed in an erosional cut in the cover near the center of the south slope of the "new landfill". The leachate flows from the landfill and down the erosional cut towards the base of the landfill where standing water was periodically observed during wet seasons.

Inorganics in Leachate. Relatively higher concentrations of metals were detected in the leachate than in the surrounding groundwater, soils, surface water or sediments. Metals in leachate can migrate into the ambient environment along the same pathways described above. Metals concentrations in leachate tend to increase as metal complexes dissolve into leachate from the waste mass under highly reducing anaerobic biodegradation conditions present in the landfill. These conditions are not suitable for metals precipitation which would reduce the metals concentrations in the leachate. Concentrations of metals in leachate that migrates to the surface and subsurface environments is attenuated through dilution, adsorption, precipitation and oxidation/reduction. Concentrations of metals in the leachate will drop rapidly when exposed to oxygen, as metal complexes form.

Organics in Groundwater – Surficial Sand/Clay Till. A limited number of VOCs were detected in groundwater samples from the on-site surficial sand monitoring wells. Shallow groundwater within the surficial sand flows toward, and discharges to, Sequoit Creek. Strong horizontal gradients are present in the surficial sand and result in rapid ground water flow (4 to 215 ft/yr). Groundwater elevation data also indicate the presence of a very slight downward vertical gradient within the surficial sand aquifer and the clay-rich diamict aquitard. However, the RI data indicate that the hydraulic conductivity of the surficial sand is more than two orders of magnitude greater than that of the clay-rich diamict. Therefore, dissolved constituents will readily migrate horizontally toward Sequoit Creek rather than vertically into the clay aquitard.

Based on the information presented, groundwater flow and contaminant migration in the vicinity of the southeast and southwest corners of the "old landfill" is toward Sequoit Creek, with the shallow groundwater discharging to the Creek. The surface water and sediment analytical results indicate that the contaminants detected in on-site shallow groundwater samples are not detected in the Creek.

Trichloroethene was detected at one Site well in the clay till aquitard. This compound will migrate slowly with groundwater flow in the clay till. Groundwater flow is slow, and predominantly downward, through the low permeability clay aquitard under the existing hydraulic gradient. The attenuation of organic and inorganic contaminants is high within the clay, primarily through adsorption. Further dilution and biodegradation can also occur, although biodegradation is probably limited within the clay till.

Organics in Groundwater - Deep Sand and Gravel. The contaminants of concern selected for the Baseline RA were only detected in the off-site deep sand and gravel aquifer at the three Village wells, VW3, VW4, and VW5, and at monitoring well US3D. The organic contaminants of concern detected in the first round samples collected from the Village wells included carbon disulfide, 2-methylphenol, and 4-chloroaniline. During the second round of sampling, detected contaminants of concern included acetone, chloroform, cis-1,2-dichloroethene, and 1,2-dichloroethane. The general lack of consistency in detections from these wells during the two rounds of sampling indicates the lack of a definite source area for these contaminants in the Village wells. The organic contaminants of concern detected in monitoring well US3D included vinyl chloride and 1,2-dichloroethene in both sampling rounds.

The contaminants detected in the deep sand and gravel can be transported with groundwater flow in the deep sand and gravel at a flow velocity between 3 and 8 ft/yr. These contaminants are attenuated through dilution, biodegradation and adsorption.

Inorganics in Groundwater. Arsenic was detected in samples from municipal wells VW-3 and VW-5, but based on the background and downgradient data, arsenic is not an analyte associated with the Site. Beryllium was also detected in the off-site surficial sand aquifer. However, beryllium was identified as a compound of potential concern only because background data for beryllium was not available. Beryllium was only detected in only one of four groundwater samples from the off-site surficial sand aquifer. It is possible that this concentration of beryllium is naturally-occurring in the surficial sand aquifer. Beryllium was not detected in samples from the on-site monitoring wells screened in the surficial sand aquifer, and thus does not appear to be associated with the Site.

Surface Water. Surface water does not appear to have been affected by the landfill. Low concentrations of two ketone compounds were detected in one surface water sample. These compounds were not detected in the second round of surface water sampling. As previously discussed, these compounds would be significantly attenuated by absorption, dilution and volatilization in surface water.

Inorganic contaminants of concern in the surface water included antimony, barium, and lead. These metals in the surface water would also attenuate through dilution, adsorption to particulate matter and precipitation along the pathways discussed in Section 1.5.1.

Sediments. SVOCs were the only compounds detected in two of the sediment samples collected from Sequoit Creek along the perimeter of the "old landfill." The primary transport mechanism for the migration of these organic compounds from the landfill to the Sequoit Creek sediments could be migration and discharge of groundwater to Sequoit Creek. The detections of these compounds could also be due to sources other than the Site. SVOCs are attenuated by dilution and biodegradation and are adsorbed to soils and sediments. Once entrained in the soils and sediments, these organic compounds will either be consumed through biodegradation or will be released to surface water and groundwater and further attenuated by dilution.

As described in the Baseline RA, the metals detected in sediments are arsenic and thallium. These metals are attenuated through adsorption and precipitation as they migrate through the pathways discussed in Section 1.5.1. The metals can be released to the surface water under physical agitation or can be dissolved into surface water through the reduction of the metals in a reducing sediment environment. Once in the surface water, oxidation is likely to cause the metal complex to precipitate and be transported with surface water flow.

Surface Soils. The surface soil organic and inorganic impacts on the Site appear to be primarily related to localized LFG and leachate seeps through the landfill cap. As the leachate and LFG migrates through the cover material, many VOCs are volatilized into the air. Other less volatile and inorganic constituents are adsorbed to the surface soils. Precipitation may then transport these constituents to surface water and/or groundwater through overland run-off and infiltration.

Phthalates detected in the surface soils are strongly adsorbed to the organic materials in the soils, and thus will resist leaching into the groundwater. To a limited extent, biodegradation may also occur in surface soils. PNAs found in the surface soils are also strongly adsorbed to soils, have low water solubilities, and are therefore not expected to be mobilized by precipitation. Under aerobic conditions PNAs will undergo natural biodegradation. The inorganics determined to be contaminants of concern in the Baseline RA were selected due to the lack of regional background data. These metals are attenuated in the surface soils. Precipitation and oxidation also occur as the metal complexes are exposed to the atmosphere.

1.6 SUMMARY OF THE BASELINE RISK ASSESSMENT

The Baseline RA was developed in accordance with the techniques described in the U.S. EPA's Baseline RA Guidance, and as subsequently modified by the U.S. EPA's "presumptive remedy for CERCLA Municipal Landfill Sites" September, 1993 (EPA 540-F-93-035). The presumptive remedy approach streamlines the process of identifying the need for, and nature and extent of, landfill site remediation. Through discussions with U.S. EPA Region V, the presumptive remedy guidance was interpreted to mean that the Baseline RA need not evaluate potential risks to a hypothetical future on-site resident. Rather, the need for on-site remediation was assessed in the Baseline RA by comparing the on-site groundwater concentrations to Safe Drinking Water Act Maximum Contaminant Levels (MCLs), non-zero MCL Goals (MCLGs), and the available Illinois drinking water standards. Consistent with a more traditional approach, the Baseline RA also addressed potential human health and environmental impacts associated with the presence, or possible migration, of site-related chemical contaminants from the landfill. ICF Kaiser Engineers, Inc. (ICFKE) and the Weinberg Consulting Group, Inc. (Weinberg Group) prepared the Baseline RA. The IEPA and U.S. EPA reviewed and commented on the Baseline RA, and approved the final Baseline RA on October 29, 1997.

The Baseline RA was conducted to characterize the current or potential future threat to human health and the environment that may be posed by chemicals originating at, or migrating from, the Site. The Baseline RA was based on data and information obtained during the RI and during a separate site visit.

The first step in the risk assessment process was to select appropriate chemicals of potential concern, evaluate data from the RI, and include a consideration of naturally occurring background chemical concentrations in the soils and groundwater. The next step was to identify potential and complete pathways of concern to human health. The following pathways were selected for detailed evaluation:

- Incidental ingestion of on-site surface soil by trespassers on the Site.
- Dermal absorption of chemicals in on-site surface soil by trespassers on the Site.
- Dermal absorption of chemicals in Sequoit Creek surface water by trespassers on the Site.
- Incidental ingestion of Sequoit Creek sediment by trespassers on the Site.
- Dermal absorption of chemicals in Sequoit Creek sediment by trespassers on the Site.
- Groundwater ingestion from public water supply wells by nearby adult residents.
- Groundwater ingestion from private wells by nearby adult residents.

- Groundwater ingestion from off-site groundwater monitoring wells by nearby adult residents (surficial sand and the deep sand and gravel aquifers).

- Inhalation of volatile organic chemicals while showering with groundwater from public water supply wells by nearby adult residents.

- Inhalation of volatile organic chemicals while showering with groundwater from the off-site deep sand and gravel aquifer by nearby adult residents.

- Dermal absorption while showering with groundwater from public water supply wells by nearby adult residents.

- Dermal absorption while showering with groundwater from private wells by nearby adult residents.

- Dermal absorption while showering with off-site groundwater (surficial sand and the deep sand and gravel aquifers) by nearby adult residents.

- Inhalation of volatile organic chemicals emitted from the landfill surface by nearby residents.

Potential exposures within each identified pathway scenario were then calculated using reasonable maximum exposure (RME) protocols. This evaluation, instead of the most likely exposure (MLE) was used so that a conservative estimate of risks at the Site would be produced. It is likely that if MLE risk estimates were used, the results of the Baseline RA would not indicate unacceptable risks.

Chemical concentrations at the potential points of exposure were calculated and combined with information on the magnitude, frequency, and duration of potential exposures. Mathematical models were used to estimate exposure point concentrations in indoor air while showering and in ambient air from LFG emissions. Once this step was completed, RME excess lifetime cancer risks and RME hazard indices were calculated for the predominant chemicals in each exposure pathway.

A summary of the Baseline RA results is shown in Table 1-9. Only one chemical in one pathway, ingestion of vinyl chloride from the off-site deep sand and gravel aquifer groundwater, exceeded the established cancer risk guideline (1×10^{-4}) used to determine if corrective action is warranted. The excess lifetime cancer risks from inhalation and dermal absorption of vinyl chloride while showering with off-site deep sand and gravel collectively add a risk of 9×10^{-5} to the ingestion risk of 8×10^{-4}. Other chemicals that posed an excess lifetime cancer risk greater than 1×10^{-6} were:

- Beryllium – ingestion and dermal absorption while showering with off-site surficial sand and gravel aquifer groundwater

- Arsenic – ingestion of municipal well water

However, based on RI data regarding the location, frequency and magnitude of detection, vinyl chloride, beryllium and arsenic may not be site-related chemicals. In accordance with the Technical Work Plan for the Baseline RA, the concentrations of chemicals in on-site groundwater were compared to federal and State standards and guidelines. Thallium, manganese, and vinyl chloride exceeded established standards as described in the Baseline RA. However, thallium and vinyl chloride were only detected in one sample out of three and one sample out of twelve, respectively.

An ecological risk assessment was also conducted to evaluate potential impacts on nonhuman receptors associated with the Site. The evaluation showed that potential risks to plants, aquatic life, and terrestrial wildlife were minimal.

In summary, the Baseline RA evaluated risks to human health from potential and complete pathways. These pathways included various exposure scenarios from surface soil, surface water, sediment, groundwater from public and private wells, and groundwater from off-site wells. Only one exposure scenario, ingestion of vinyl chloride from the off-site deep sand and gravel aquifer groundwater, exceeded established cancer risk guidelines. The human and ecological risk assessments support the conclusion that biological populations and the communities in the vicinity of the Site have not been adversely affected by chemicals present at, or potentially migrating from, the Site. It should be noted that the only exposure scenario that exceeded the established risk guidelines (the ingestion of vinyl chloride from the off-site deep sand and gravel aquifer groundwater) is unlikely because use of groundwater from the Site vicinity has been eliminated by the Village of Antioch ordinance requiring properties within the Village limits to connect to the municipal water supply system and the fact that VW4 has been taken out of service.

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2.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

The primary objective of this phase of the FS is to develop appropriate remedial action alternatives that will be analyzed fully in the subsequent detailed evaluation phase of the FS (see Section 4). Appropriate remedial alternatives are developed by assembling combinations of technologies, and the media to which they would be applied, into alternatives that would address the identified Site conditions and risks. The NCP provides considerable latitude regarding the scope of this screening and development phase. As stated in the NCP §300.430(a)(1)(ii)(C): "Site-specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems being addressed." The NCP preamble discussion states that it is U.S. EPA's intent to balance the desire for definitive site characterization and alternatives analysis with a bias for initiating response actions as early as possible. The preamble emphasizes the principle of streamlining, which the U.S. EPA applies in managing the Superfund program as a whole, and in conducting individual remedial action projects. In accordance with the principle of streamlining, an alternatives screening step may be deemed unnecessary prior to detailed analysis. Of particular relevance for this FS is the fact that U.S. EPA has developed presumptive remedies for CERCLA municipal landfill sites. It is U.S. EPA's intent to use presumptive remedies to accelerate site-specific analysis of remedies by focusing feasibility study efforts. According to U.S. EPA guidance, use of the presumptive remedy approach eliminates the need for the initial step of identifying and screening a variety of alternatives during the FS. This FS will use presumptive remedy guidance to greatly simplify the technology identification and screening process.

To develop remedial action alternatives, remedial action objectives and applicable or relevant and appropriate requirements (ARARs) must be established. Remedial action objectives are requirements for the Site that provide adequate protection of human health and the environment. ARARs are standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstances.

2.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives provide the foundation upon which remedial cleanup alternatives are developed. Remedial action objectives should reflect U.S. EPA's remedy selection expectations, as presented in NCP §300.430(a)(1)(iii). Where practicable, U.S. EPA expects to treat principal threats, employ engineering controls (e.g., containment) for low-level threats, use institutional controls to supplement engineering controls, and restore usable groundwaters to beneficial uses. Site-specific objectives usually relate to specific contaminated media (such as groundwater or soil), potential exposure routes, and to the identification of target remediation levels. Site-specific objectives are based on the evaluation of risks to human health and the environment, identified in the Baseline RA, and are established in consideration of the ARARs.

2.1.1 NCP and CERCLA Goals

The following two goals constitute the general objectives for remedial actions at all CERCLA sites.

1. The NCP states: "The appropriate extent of remedy shall be determined by the lead agency's selection of a cost-effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and the environment" (40 CFR 300.68 (i)). For the H.O.D. Landfill Site, the lead agency is U.S. EPA.

2. The statutory scope of CERCLA was amended in 1986 by SARA to include the provision that the selected remedy must comply with or attain the level of any "standard, requirement, criteria, or limitation under any Federal environmental law or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation" [Section 121(d)(2)(A)].

U.S. EPA has developed presumptive remedies for CERCLA municipal landfill sites. Presumptive remedies are preferred technologies for common types of sites, based on historical patterns of remedy selection and U.S. EPA's own evaluation of performance data. It is U.S. EPA's intent to use presumptive remedies to accelerate site-specific analysis of remedies by focusing feasibility study efforts. This presumptive remedy approach was used to streamline the selection of remedial alternatives for the H.O.D. Site. According to U.S. EPA guidance, the presumptive remedy for CERCLA municipal landfill sites is containment and access restrictions.

In addition, U.S. EPA guidance for municipal landfill sites explains that the decision to characterize and treat hot spots in a landfill should be based on whether the combination of the waste's physical and chemical characteristics and volume is such that the integrity of the containment system will be threatened if the waste is left in place. This decision is to be based on available site information. Based on historical records and the results of the RI and Baseline RA, no leachate hot spots were identified and therefore the characterization and treatment of hot spots is not supported at the H.O.D. Site for the following reasons:

- The estimated volume of in-place waste is approximately 1.5 million cubic yards.

- Concentrations of contaminants of concern detected in on-site soils and groundwater did not exceed the established cancer risk guidelines used to determine if corrective action is warranted.

- No groundwater plume has been identified in association with the Site.

Thus, well-defined hot spots are not apparent at the site and the integrity of the containment alternatives described in Section 3 will not be threatened if the waste is left in place.

2.1.2 General Site Response Action Objectives

The Baseline RA was developed using the U.S. EPA's "Presumptive Remedy for CERCLA Municipal Landfill Sites," September 1993 (EPA 540-F-93-035) which identifies containment as the presumptive remedy. The State of Illinois 35 IAC 807 and 811 General Standards for Landfills were also used to establish the following general response action objectives:

- Preventing direct contact (dermal contact or ingestion) with impacted soil and landfill contents.
- Controlling infiltration and contaminant leaching to groundwater.
- Preventing inhalation and controlling fugitive vapors and dust.
- Controlling surface water runoff and erosion.
- Preventing migration of contaminants from source areas.
- Controlling and treating landfill gases (LFG).

Preventing direct contact with soil and waste, controlling infiltration and leachate generation are typically addressed by capping the Site and/or institutional controls. The control of leachate and LFG are typically addressed by installing and operating engineered leachate and gas collection systems. These three components have already been implemented at the Site during its initial closure in 1988, and based on the results of the Baseline RA, they are effective in reducing risks at the Site to acceptable levels. The only unacceptable risk presented in the Baseline RA was associated with the presence of vinyl chloride in the deep sand and gravel aquifer. It should again be noted that the source of this vinyl chloride may not be the H.O.D. Landfill. However, if the landfill is a contributor of vinyl chloride to the groundwater, the most effective way to control further release of this and other volatile organic compounds to the groundwater is to control the LFG and leachate within the waste mass. Many professional papers (Fenestra, 1992, Barber et al., 1990) and textbooks (Bagchi, 1994, Academic Press) have been published explaining the effect of dissolution of LFG contaminants into leachate and groundwater. Therefore, to reduce the potential for this phenomenon, various improvements on the existing cap, LFG control system and leachate collection system could be implemented in order to enhance their effectiveness.

The VOCs found in the surficial sand were not found to be migrating off-site, indicating that active groundwater controls in the off-site surficial sand aquifer is not needed. However, potential future release of VOCs to the on-site surficial sand would also be further controlled by enhancements to the existing LFG and leachate collection systems.

Control of surface water runoff and erosion are usually addressed by constructing and maintaining silt checks, sediment basins, and establishing vegetation. Prevention of fugitive vapors and dust is usually accomplished by watering construction areas for dust control during construction, and maintaining the vegetation and soil cover on the site.

2.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

The 1986 SARA adopted and expanded a provision in the 1985 NCP which stated that remedial action must at least comply with ARARs. Amendments in SARA also require compliance with federal and state ARARs, such as state environmental or facility siting laws, whenever the state requirements are promulgated, more stringent than federal laws, and identified by the state in a timely manner.

Generally, laws and regulations adopted at the state level, as distinguished from the regional, county or local level, are considered as potential state ARARs. Local laws, in themselves, are not ARARs, unless they are both adopted and legally enforceable by the state (OSWER publication 9234.2-05/FS, December 1989).

2.2.1 Definitions of ARARs

Applicable requirements are standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstance. For a requirement to be applicable, the remedial action or the circumstances at the Site must satisfy all of the jurisdictional prerequisites of that requirement. For example, the requirements governing construction in a floodplain would only be applicable if construction of a remedial alternative actually encroached into a floodplain.

Relevant and appropriate requirements are standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable to a CERCLA site, address problems or situations sufficiently similar to those encountered at the Site. In some circumstances, a requirement may be relevant to the particular site-specific situation but will not be appropriate because of differences in the purpose of the requirement, the duration of the regulated activity, or the physical size or characteristic of the situation it is intended to address. There is more discretion in the determination of relevant and appropriate requirements than in the determination of applicable requirements. Therefore, it is possible for only a part of a given requirement to be relevant and appropriate.

Additional factors to consider when evaluating whether or not a requirement is potentially relevant and appropriate are whether the requirement is substantive or administrative, and whether the action is an on-site or off-site activity. Substantive requirements are those that pertain directly to actions or conditions in the environment. Administrative requirements are those mechanisms that facilitate the implementation of the substantive requirements of a statute or regulation. In general, administrative requirements prescribe methods and procedures (such as fees, permitting, inspection, and reporting requirements) by which substantive requirements are made effective. On-site CERCLA response actions must comply with substantive requirements, but not with administrative requirements. For example, an on-site CERCLA response action must meet the intent of the law (substative requirements), but need not conform with all applicable permitting or licensing rules (administrative requirements). This distinction applies only to on-site actions; off-site response actions are subject to the full requirements of applicable standards or regulations, including both substantive and administrative requirements.

In addition to the legally binding requirements established as ARARs, many federal, state and local programs have developed criteria, advisories, guidelines or proposed standards that may provide useful information or recommend procedures if ARARs are not available to address a particular situation. The use of these advisories, criteria or guidance to-be-considered (TBCs) that do meet the definition of ARARs, may be evaluated along with ARARs to determine the necessary level of cleanup or develop Superfund remedies. TBCs are, by definition, generally neither promulgated nor enforceable so they do not have the same status under CERCLA as ARARs. Local laws also are not ARARs, but may be TBCs.

2.2.2 Classification of ARARs

A description of the three distinct ARAR classifications is given below, while comparison of the remedial actions with each of the ARARs is presented in Section 4.

The U.S. EPA defines three types of ARARs:

- Chemical-specific
- Location-specific
- Action-specific

2.2.2.1 Chemical-Specific ARARs. Chemical-specific ARARs include those laws and requirements that regulate the release of materials having certain chemical or physical characteristics, or materials containing specified chemical compounds to the environment. These requirements generally establish health- or risk-based concentration limits or discharge limitations for specific hazardous substances.

Chemical-specific potential ARARs for the H.O.D. Site have been identified for surface water, groundwater and air. Significant potential ARARs include Illinois water quality standards, leachate pretreatment standards, effluent guidelines, groundwater quality standards, and air quality standards.

2.2.2.2 Location-Specific ARARs. Location-specific ARARs are those requirements that relate to the geographical or physical position of the Site, rather than to the nature of the contaminants or the proposed site remedial actions. These requirements may impose additional constraints on the remedial actions selected for the Site. Floodplain restrictions, wetland restrictions and protection of fish and wildlife are among location-specific potential ARARs for this site.

Location-specific ARARs for wetlands have been identified as potentially relevant and appropriate for this Site because of the proximity of wetlands to the landfill areas. However, the identified wetland areas are outside of the landfill footprint, and potential construction activities presented in Section 3 would take place within the capped area only and will not encroach upon the wetland areas.

Similarly, floodplain ARARs have been included as potentially relevant and appropriate requirements. Floodplain maps developed before the development of the "new landfill" area show that the "old landfill" area was outside the 100-year floodplain. Based on flood elevations of 766 to 767 feet MSL, the "new landfill" area is also above the floodplain elevation. Construction activities conducted as part of the potential response actions evaluated for the Site are not expected to have detrimental impacts on the floodplain.

Because of the proximity of Sequoit Creek, the Fish and Wildlife Coordination Act is listed as a potential location-specific ARAR. Under the remedial action alternatives proposed, no control or structural modifications will be made to Sequoit Creek. In addition, no filling or dredging of the Creek is proposed in this evaluation.

2.2.2.3 Action-Specific ARARs. Action-specific ARARs are requirements that define acceptable treatment and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to achieve remedial action objectives. Potential action-specific ARARs for the H.O.D. Site include specific requirements governing landfill closure; post-closure care; landfill gas collection and treatment; and leachate collection, treatment, and discharge.

2.2.3 ARARs for the HOD Site

The potential ARARs for the Site are presented in Tables 2-1 through 2-3. These tables were developed jointly by U.S. EPA, IEPA, and WMII, in accordance with U.S. EPA guidance and Illinois State laws. It is important to note that the H.O.D. Site stopped accepting waste before October 9, 1993 and was closed under 35 IAC 807; therefore, the site is exempt from the requirements of 35 IAC 814, as specified in 35 IAC 814.107(b). Also, the site is not governed by the standards set forth in 35 IAC 811, which explicitly declare applicability to "new landfills, except as otherwise provided in 35 Ill. Adm. Code 817, and except those regulated pursuant to 35 Ill. Adm. Code 700 through 749" in 35 IAC 811.101(a). Therefore, 35 IAC 807 is the primary applicable state requirement. 35 IAC 811 may be deemed relevant and appropriate only in that it requires more stringent measures than 35 IAC 807. However, since the Baseline RA has determined that the Site poses minimal risk to human health and the environment, and since the Site was closed before the implementation of 35 IAC 811, 35 IAC 811 is neither applicable nor relevant and appropriate. (See also the City of Woodstock vs. Mary Gade and the IEPA, Illinois Circuit Court for the 19th Judicial Circuit, Gen. No. 96 MR 206).

2.3 GENERAL RESPONSE ACTIONS

The general response actions presented in this section describe broad types of action which could be conducted to satisfy the remedial action objectives. Response actions are selected on the basis of their applicability to site conditions and media of concern. An individual general response action may be capable of meeting all of the remedial objectives; however, combinations of response actions are typically more effective or economical. Potential general response actions for the H.O.D. Site were gathered from U.S. EPA guidance documents (including presumptive remedy guidance), literature review, and experience at other sites.

General response actions identified for the H.O.D. Site are:

- No Action
- Access Restrictions
- Capping
- Gas Collection/Treatment
- Leachate Collection/Treatment
- Groundwater Monitoring
- Groundwater Contingent Remedy

In order to discuss the relevance of capping, LFG collection and treatment, and leachate collection as general response actions, the interrelationships between these three common measures should also be understood. Therefore, within each of the following discussions, the dependence of each of these measures on the other two will be explained. A general description of each of the above bulleted items is given below.

2.3.1 No Action

This alternative provides a baseline for comparing other alternatives, and assumes that no additional remedial response actions would be implemented under CERCLA. The landfill has a continuous soil cover ranging in thickness from 49 inches to 87 inches. A passive LFG venting and combustion system is in place at the Site. In addition, a leachate collection and discharge system is in place, and is operated to remove approximately 6,000 to 8,000 gallons of leachate per week. The site is partially fenced to limit access. A routine groundwater monitoring program is regularly implemented at the Site.

2.3.2 Access Restrictions

Access restrictions contribute to meeting all the remedial action objectives limiting human exposure to the Site, limiting how the Site can be used now and in the future, and educating potential site users and trespassers of the Site contents and their potential hazards. Access restrictions will include site fencing, signage, gates, and deed restrictions.

2.3.3 Capping

The existing cover on the Site serves to control infiltration, contain the landfill contents and generally limit exposure to the waste mass. Upgrades to or repair of the existing cap on the landfill could address one or more of the general remedial action objectives, listed previously, to varying degrees. Repair of the existing cap would serve to reduce ponding and the associated infiltration of surface water, and contain leachate seeps and landfill gas (LFG).

The major effects of a continuous cap over the waste mass are threefold. In general, a cap:

1. Controls the release of LFG to the atmosphere, which causes buildup of LFG pressures. Once generated, LFG will migrate to areas of lower pressure with a concomitant increase in partitioning of LFG contaminants into the leachate and/or groundwater in direct subsurface contact with the LFG.

2. Controls the generation of leachate by limiting the infiltration of storm water into the waste mass.

3. Prevents direct contact with the waste mass, and effectively eliminates the potential for off-site transport of refuse or debris.

Therefore, by capping a landfill, LFG production will increase and leachate production will decrease. In this case, the chemical concentrations in both the LFG and the leachate may increase due to the reduced infiltration and LFG emissions.

As part of the containment measures, regardless of which capping option is selected, a small amount of waste located outside the property line on the north end of the "old landfill" area would be either be consolidated within the landfill waste mass or would remain in place if WMII acquires this portion of the adjacent property. If WMII acquires the property, the selected capping option would extend over this particular area.

As a common element within each capping option, surface water controls to direct stormwater runoff from the Site, and to prevent off-site surface water from running onto the Site, would be implemented. Specifically, Sequoit Creek would be protected through the implementation of erosion control measures (detailed in Section 3) and by the placement of temporary silt fencing between the creek bank and active construction areas. Surface water controls may include grading to manage the stormwater runoff, the use of soil erosion control measures such as revegetation, and the placement of straw bales in the site ditches.

2.3.4 Gas Collection/Treatment

The existing passive LFG control system consists of 14 passive flares in the "new landfill" area. Refer to Figure 10 for the locations of these features. A passive LFG control system allows the LFG pressure within the waste mass to build-up, eventually causing the LFG to vent. An upgrade of the existing LFG collection and treatment system would be capable of meeting the general remedial action objectives by controlling the build-up and migration of landfill gas. These measures would prevent direct contact/inhalation threats, uncontrolled migration of the LFG, eliminate potential explosion hazards posed by the methane in the LFG, and significantly reduce the dissolution of chemicals (mainly VOCs) in the LFG into the leachate and/or groundwater. An active LFG system uses a mechanical device (usually a blower) to produce a vacuum within the collection devices (usually wells or perforated header pipes), thereby pulling LFG out of the waste mass. Performance of both active or passive systems can be increased by increasing the number of LFG venting or collection points.

Active collection and treatment of LFG serves to:

1. Reduce the LFG pressures that will naturally build under a landfill cap, reducing the potential for off-site migration of LFG, and potential for stressed vegetation on the cap.

2. Reduce the mass of the volatile constituents present in the landfill waste mass by maintaining a consistent flow of LFG out of the landfill. This in turn reduces the contaminant concentrations in the leachate, as fewer contaminants are partitioned into leachate. The removal of LFG can eliminate thousands of pounds of VOCs per year from the waste mass. It has been demonstrated that LFG controls may be significantly more effective in reducing volatile organic compound concentrations in groundwater (by several orders of magnitude) than groundwater removal/treatment systems.

3. By reducing the contaminant concentrations in the leachate, the potential for adverse impacts to groundwater is reduced.

Methane concentrations measured at the Site during the RI range from 65 to 68 percent in the "new landfill" area and 72 percent in the "old landfill" area. VOCs found in the landfill gas include the following five groups: ketones, aromatics, alkenes, alkanes, and other VOCs. A summary of the concentrations of VOCs found in LFG at all of the sampling locations is provided in Table 1-2.

2.3.5 Leachate Collection/Treatment

The volume of leachate within the Site is currently estimated to range from 69 to 96 million gallons. Currently, leachate is collected in pipes and directed to manholes (MHE and MHW) where approximately 35,000 gallons of leachate per month are extracted. Refer to Figure 10 for the locations of these features. Leachate collection and off-site disposal are currently conducted at the Site in order to maintain compliance with the existing IEPA permit for the Site. The current measures could be upgraded to meet the remedial action objectives of minimizing leachate build-up and eliminating potential seeps through the landfill side slopes. Leachate collection reduces potential migration of leachate to surface water and groundwater. It should be noted that upgrades to the leachate collection system at the Site would also likely induce an inward gradient and to some degree capture shallow groundwater in the surficial sand aquifer in the immediate vicinity of the Site.

Collection of leachate from the waste mass:

1. Maintains hydraulic control of the liquid levels within the waste mass, reducing the potential for off site migration.

2. Increases the production of LFG, attributable to anaerobic digestion, by reducing leachate levels, creating more favorable conditions within the waste mass for anaerobic digestion to occur.

3. Reduces the potential dissolution of LFG contaminants into the leachate by reducing the volume of leachate available within the waste mass.

2.3.6 Groundwater Monitoring

A routine groundwater monitoring program is currently performed at the Site in accordance with the existing IEPA Site permit. This current groundwater monitoring and sampling program could be revised to more thoroughly address the effectiveness of the selected remedy with respect to identified groundwater impacts. The monitoring plan would entail sampling of select existing downgradient wells at the Site for the contaminants of concern. While groundwater monitoring does not directly address the remedial action objectives, it serves as a measuring tool to ensure that the other remedial actions implemented at the Site are meeting their respective remedial action objectives, and does comply with 35 IAC 807.

2.3.7 Contingent Groundwater Remedy

If, at some time in the future, periodic groundwater monitoring results indicate an unacceptable change in the groundwater quality, a contingent groundwater response may be evaluated.

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3.0 REMEDIAL ACTION ALTERNATIVES

This section identifies a variety of specific remedial action alternatives that could satisfy the remedial action objectives previously identified in Section 2. The technologies and process options described below include institutional controls, various engineered barriers, leachate and LFG collection and treatment, and groundwater monitoring upgrades (if necessary). This FS evaluates and incorporates presumptive remedies and ARAR-defined response actions to the maximum extent practicable in order to minimize detailed technology evaluation and screening, to accelerate the remedial process.

3.1 ACTION ITEMS COMMON TO ALL REMEDIAL ACTION ALTERNATIVES

The remedial action alternatives developed in this section are presented with the underlying assumption that regardless of the alternative(s) selected, the following site-related action items will be implemented or continue at the H.O.D. Site:

- Deed restrictions and institutional controls
- Site access restrictions
- Routine post-closure upkeep consisting of cap maintenance, stormwater control, and LFG and leachate collection and treatment
- Groundwater monitoring

Currently, Site access is restricted, and a landfill cap, LFG venting/flare system, and leachate collection system are in place at the Site. The LFG and leachate collection systems are operated in accordance with the IEPA permit requirements for the Site. A routine groundwater monitoring system is also in place at the Site.

Access restrictions to be evaluated for the Site include upgrading the existing fencing and signage, gates, and deed restrictions. Upgrading the existing fence will improve site security and restrict access to the Site by unauthorized individuals. A newly constructed chain link fence would be six-feet high with three strands of barbed wire at the top. Approximately 2,000 lineal feet of fencing would be needed to either replace or augment the existing fence and completely enclose the Site. Locking gates would be located at entry points. Signs would be posted every 300 feet along the fence at a height of approximately five feet. The signs would convey the following:

WARNING!

H.O.D. LANDFILL
AUTHORIZED PERSONNEL ONLY

THIS AREA MAY CONTAIN HAZARDOUS CHEMICALS IN THE SUBSURFACE SOILS AND GROUNDWATER.

CALL ___-___-____ FOR FURTHER INFORMATION

Restrictive covenants on deeds to the Site would be maintained to prevent or limit site use and development. The covenants would notify a potential purchaser of the property of the past landfill activities and would assert that the land use must be restricted to ensure the continued integrity of the waste containment remedy.

The current groundwater monitoring program would continue to evaluate the effectiveness of the chosen remediation alternatives and document the concentrations of the chemical constituents in groundwater. The monitoring program should identify specific monitoring locations, frequencies and analytical parameters.

3.2 SUMMARY OF POTENTIAL ADDITIONAL REMEDIAL ACTION COMPONENTS

The following potential supplemental remedial action components have been developed and are summarized in Table 3-2:

- No Further Action

- Capping
  - C1 – Landfill cap restoration and maintenance - As described in the Site Conditions (see Section 1.3), 49" to 87" of soil currently cover the waste mass. The soil is primarily clay with a surficial vegetated topsoil layer. In this alternative, the cap would be restored and maintained at the grades that existed when the Site was closed in 1988. Clay would be imported to fill low areas and repair leachate seeps. The Site would then be graded to promote drainage and eliminate surface water ponding. Topsoil would be placed atop the clay and seeded to match existing vegetation.
  - C2 – Augmentation of the existing landfill cap - The existing cover soils would be reworked to form a uniform 35 IAC 807-compliant cap consisting of two feet of compacted clay with additional 24" of cover soil, the top six inches of which would consist of topsoil. The topsoil layer would be seeded to establish vegetation.
  - C3 – Reconfiguration/supplementation of existing landfill cap - The existing cover soils would be reworked and supplemented (if necessary) to form a 35 IAC 811-compliant cap consisting of three feet of compacted clay and three

feet of cover soil, the top six inches of which would consist of topsoil. The topsoil layer would be seeded to establish vegetation.

In all three alternatives, the vegetation is assumed to be primarily native grasses that would minimize erosion and promote evapotranspiration.

- LFG Collection and Treatment
  - Gl – No further action - Continue to passively vent and destroy LFG with existing stick flares. These stick flare locations are shown on Figure 4.
  - G2 – Supplement the existing LFG system – The existing passive flare system in the new landfill area would be maintained, as necessary, and continue to be operated. LFG collection and treatment would also be supplemented through the addition of an active LFG control system in the old landfill section, consisting of new vertical wells interconnected by header piping to a blower/flare station. A pilot/predesign study would be conducted to determine the necessary repairs in the new landfill area and the optimum locations for placement of vertical wells in the old landfill area.
  - G3 – Active site upgrade of LFG system – The existing stick flares would be utilized as LFG extraction points (as necessary), additional wells in the old portion of the Site would be installed (as needed), and a header system would be installed to convey LFG to one centralized blower/flare station forming an entirely active treatment system. As in the case of G2, a series of pilot/predesign studies would be conducted to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. The results of these pilot/predesign studies may indicate that the fully active system proposed under G3 is not necessary, and that G2 is sufficient to address the LFG at the Site.

- Leachate Collection
  - LCl – No further action, Continue to utilize the existing leachate extraction protocols and collection points.
  - LC2 – Toe-of-slope leachate collection - The toe-of-slope collection piping would be extended along the toe of both the old and new sections of the landfill and the existing extraction points (P1, P2A, P3A, and P8-P10) would be used. The entire system would be automated.
  - LC3 – Upgrade/Supplementation of leachate system - The toe-of-slope collection piping would be extended along the toe of the landfill in the new section only; existing extraction points in the new section would also continue to be used. A dual extraction system consisting of 5 new wells interconnected with existing wells and header piping to a blower/flare station would be constructed in the old section of the landfill. A pilot/predesign study would be undertaken to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. It should be noted that this alternative would be considered in conjunction with the LFG alternative G2, because the required construction for each of these alternatives

is similar (i.e., use existing systems with minor upgrades in the new landfill area, install new wells in the old landfill).
  - LC4 – Active Leachate Extraction – Existing gas and leachate wells (GWF1-GWF14 and LP1-LP14) in both the old and new sections of the landfill would be converted to dual extraction wells. The existing LFG wells would be used for additional extraction points. As in the case of LC3, a pilot/predesign study would be undertaken to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. The entire system would be automated. It should be noted that this alternative would be considered in conjunction with the LFG alternative G3, because the required construction for each of these alternatives is similar (i.e., install new wells as necessary across the Site, install header piping and automate the entire system).

- Leachate Treatment/Disposal
  - LT1 – No further action - Continue to directly discharge to a licensed POTW.
  - LT2 – Pretreat leachate, discharge to POTW – Pretreatment of leachate via physical/chemical processes would be done before discharge to a POTW.
  - LT3 – Treat leachate, surface discharge – Full treatment of leachate to NPDES standards would be done prior to remote surface discharge to a surface water source of adequate assimilative capacity (not Sequoit Creek).

- Contingent Groundwater Remediation
  - GW1 – No further action
  - GW2 – Implementing well head treatment.

Costs for each of the above alternatives are presented at the end of the detailed descriptions found in the following sections. A cost summary table is included as Table 3-3. These cost estimates were prepared for each element of the various alternatives, using available sources of information such as Means© construction cost data, engineer's estimates, bid costs for similar work, quotes from vendors and contractors, and engineering judgment. However, the actual construction costs for any selected remedy will reflect the project specifications, the actual labor and material costs at the time of construction, the market conditions, the final project schedule, and other less quantifiable factors. Consequently, the cost estimates presented for each alternative must at this time be considered approximate, with a range of accuracy of +50% to -30%.

3.3 NO FURTHER ACTION

The NCP requires the 'No Action' response alternative to be carried through detailed analysis. Under this option, no further remedial actions would be implemented at the Site under CERCLA. However, the routine operation and maintenance activities currently being performed at the Site under the existing IEPA permit, which include cap maintenance and operation and maintenance of the existing (passive) LFG and manual leachate collection systems, would continue under this alternative. The groundwater monitoring activities being performed at the Site would also continue under this alternative. The existing site security fence and deed restrictions would remain in place along with all existing Site control features, including the in-place landfill cover and the leachate and LFG collection and control systems. The following estimated cost is associated with the no further action alternative:

- Capital Cost $0
- Annual O&M $218,000
- Total Present Worth (30 yrs @ 5%)..... $3,350,660

It should be noted that the decommissioning of VW4 and installation of VW7 have already been completed at a cost of $693,900 (See Appendix C for details).

3.4 CAPPING

3.4.1 C1 – Landfill Cap Restoration and Maintenance

This alternative involves using off-site clay or cover materials from the existing cap to restore the cap to the approximate grades which existed when the site was closed in the late 1980s. Based on observations and performance to date, the "old landfill" has an excellent vegetative cover and is very uniform over the entire area. The "new landfill" area has some limited areas of erosion, differential settlement and resulting ponded water. Therefore, the existing cap repairs would be limited to the "new landfill" area, with potential repairs on the "old landfill" area. The cap repairs would be performed by supplementing the existing cover, thus adding thickness to the existing soil cover of 49 to 87 inches. After grading is completed to promote drainage and reduce ponding, a 6 inch thick (minimum) topsoil layer would be placed on the repaired areas and seeded to establish vegetation. The resulting dual layer cap would meet or exceed the final cover specifications embodied in 35 IAC 807 (which call for "a compacted layer of not less than two feet of suitable material").

Construction activities would include the removal of vegetation, stockpiling of topsoil to be reused as vegetation layer soils, consolidation of the off-property waste at the northern edge of the "old landfill" onto Site property, regrading, placing and compacting the clay soils, placing the vegetation layer soils (uncompacted), and re-establishing the vegetation. The existing landfill access roads are adequate; therefore, the construction of additional access roads is not included under this capping alternative. Construction activities would be planned to avoid encroaching upon or impacting the adjacent wetlands or floodplain.

The regrading of the Site would be performed to improve areas of the landfill that have been affected by erosion and/or settlement, to create and maintain a continuously sloped surface sufficient to maintain positive drainage over and off the Site. The soil in the area of leachate seeps would be overexcavated and consolidated in the low areas. The resulting excavation would be backfilled and compacted with clay soils, effectively sealing the cover. The existing cover soils range in thickness from approximately four to seven feet which should provide sufficient cut and fill material balance for these regrading activities. The Site would be graded to a minimum 2 percent slope and the side slopes would be no steeper than 4H:1V. In the "new landfill" area, the existing side slopes range from 4H:1V to 6H:1V.

Appropriate erosion control measures, to protect nearby Sequoit Creek and the adjacent wetlands, would be implemented prior to construction activities. These measures would possibly include construction of berms/silt fences, rip-rap and straw bale dikes, and use of temporary cover material.

After repairs to the soil cap are made, maintenance of the cap would include mowing at a minimum of twice per year and perimeter ditch inspection and maintenance on a quarterly basis. Maintenance of the ditches would include removal of silt and debris. Quarterly inspections would include walking the Site and visually noting signs of erosion, settlement, or other damage. Any damage would be repaired. Although the majority of settlement on the Site has already occurred, additional differential settlement could occur as a result of continued or upgraded LFG and/or leachate extraction. However, no additional thickness of cover soils is planned to be placed and therefore settlement would not be expected to be significant for this option.

Infiltration would be reduced by almost two inches per year (from 4.3 inches) by these cap improvements. Approximately 2.48 inches/year of infiltration would be expected following the implementation of this cap alternative, as shown on the HELP Model Version 3 output included in Appendix B.

Construction would be expected to take approximately 9 weeks and may be completed in one construction season (May-October) with the following estimated cost:

- Capital Cost.. $1,475,000
- Annual O&M $88,000
- Total Present Worth (30 yrs @ 5%)..... $2,835,000

3.4.2 C2 – Augmentation of the Existing Landfill Cap

This alternative involves using clay and cover materials from the existing cap to rework the cap over both the old and new landfill areas. The reworked cap would uniformly consist of a two-foot compacted clay layer and a two-foot uncompacted rooting zone/cover layer to support vegetation. The resulting dual layer cap would meet or exceed the final cover specifications embodied in 35 IAC 807 (which call for a "suitable," single-layer, two-foot compacted cap material). The additional two feet of material would help to facilitate the post-closure goal of minimizing future cap maintenance by providing an additional protective layer conducive to vegetative rooting. Figure 9 presents a cross-section and conceptual details of this proposed cover configuration.

Construction activities would include the removal of vegetation, stockpiling of soils to be used as vegetation layer soils, consolidation of the off-Property waste at the northern edge of the "old landfill" onto Site property, regrading, placing and compacting the clay soils, placing the vegetation layer soils (uncompacted), and re-establishing the vegetation. The existing landfill access roads are adequate; therefore, the construction of additional access roads is not included under this capping alternative. Construction activities would be planned as at the landfill to avoid encroaching upon or impacting the adjacent wetlands or floodplain.

The regrading of the Site will be performed to improve areas of the landfill that have been affected by erosion and/or settlement, to create and maintain a continuously sloped surface sufficient to maintain positive drainage over and off the Site. Recompaction of the cover would reduce infiltration of surface water by establishing a less permeable barrier layer. All work would be expected to be performed using existing on-site soils. The existing cover soils range in thickness from approximately four to seven feet which should provide sufficient cut and fill material balance for these regrading activities. The Site would be graded to a minimum 2 percent slope and the side slopes would be no steeper than 4H:1V. In the "new landfill" area, the existing side slopes range from 4H:1V to 6H:1V.

Appropriate erosion control measures, to protect nearby Sequoit Creek and the adjacent wetlands, would be implemented prior to reworking the cap. These measures may include construction of berms/silt fences, rip-rap and straw bale dikes, and use of temporary cover material.

After the reworking of the soil cap, maintenance of the cap would continue to be required and would include mowing at a minimum of twice per year and perimeter ditch inspection and maintenance on a quarterly basis. Maintenance of the ditches would include removal of silt and debris. Quarterly inspections would include walking the Site and visually noting signs of erosion, settlement, or other damage. Any damage would be repaired. Although the majority of settlement on the Site has already occurred, additional differential settlement could occur as a result of additional weight from reworking the existing landfill cover. However, no additional thickness of cover soils is planned to be placed and therefore settlement would not be expected to be significant for this option.

Approximately 1.9 inches/year of infiltration would be expected following the implementation of this cap alternative, as shown on the HELP Model Version 3 output included in Appendix B.

Construction would be expected to take approximately 17 to 20 weeks and may be completed in one construction season (May-October) with the following estimated cost:

- Capital Cost.. $5,252,000
- Annual O&M $88,000
- Total Present Worth (30 yrs @ 5%)..... $6,610,000

3.4.3 C3 – Reconfiguration/Supplementation of the Existing Landfill Cap

This alternative includes using the soil materials from the existing cap as a "final protective layer" and using either existing on-site clay, supplemented, as needed, with off-site clay, or entirely new off-site clay as a "low permeability layer." A cap that uniformly consists of a three-foot compacted clay layer and a three-foot uncompacted rooting zone/cover soil layer and vegetative cover would be constructed. The resulting cap would comply with the final cover specifications of 35 IAC 811, which requires a low permeability layer with a minimum allowable thickness of three feet, overlain by a final protective layer, sufficient to protect the low permeability layer from freezing and minimize root penetration, not less than three feet thick. Figure 9 presents the conceptual details of this proposed cover alternative.

Construction activities would include removal of vegetation, stockpiling the cover soils for re-use as needed, consolidation of the off-Property waste at the northern edge of the "old landfill" onto Site property, re-grading the Site using existing soils to a uniform graded surface, excavating and hauling supplemental off-site clay to the site (if needed), placing and compacting clay as the barrier layer, placing the rooting zone soils, and re-establishing vegetation. A borrow-source investigation would be conducted to confirm the quality of off-site clay (if used) before it is excavated and used in the cap. It is important to note that the cap could be supplemented with clay from the previously used clay source if the clay is available in sufficient quantity and is of acceptable quality (to be determined by borrow-source testing). Existing landfill access roads are adequate; therefore, construction of additional access roads is not included under this capping alternative. Construction activities could be performed so as not to encroach upon, or impact, the adjacent wetlands or floodplain.

Regrading of the Site, using existing cover soils, would be performed to address the erosional rills, gullies, and settlement depressions that affect approximately 20 percent of the Site area. This would create a continuously sloped surface sufficient to maintain positive drainage over and off the Site and would also reduce infiltration and the formation of leachate. Recompaction of the cover would reduce the infiltrating volume of surface water by establishing a less permeable barrier layer. The Site would be graded to a minimum 2 percent slope and to a maximum 4H:1V slope on side slopes.

Appropriate erosion control measures, to protect nearby Sequoit Creek and the adjacent wetlands, would be implemented prior to reworking the cap. These measures may include the construction of berms/silt fences, the placement of rip-rap, and straw bale dikes, or the use of temporary cover material.

After the reworking of the landfill cap, maintenance would continue to be performed and would include mowing at a minimum of twice per year and site inspection on a quarterly basis. Quarterly inspections would consist of walking the Site and visually noting evidence of erosion, settlement, clogged swales, and/or other damage. Repair would be performed as needed. Maintenance of the ditches would include removal of silt and/or debris that may impair surface water flow. Additional differential settlement could occur after the reconstruction of the landfill cover as a result of the weight addition provided by the new cover soils; however, significant additional settlement would not be expected for this option.

Approximately 2.1 inches/year of infiltration would be expected following the implementation of this capping alternative, as shown on HELP Model Version 3 output included in Appendix B. It should be noted that this infiltration is greater for this thicker soil cap because the thicker soil layer is able to retain more moisture, thus allowing more of the retained soil moisture to infiltrate to the waste mass.

Construction would be expected to take approximately 22 to 27 weeks and may need to extend over the course of two construction seasons with the following estimated cost:

- Capital Cost .... Up to $9,886,000
- Annual O&M $88,000
- Total Present Worth(30 yrs @ 5%) .... Up to $11,240,000

3.5 LANDFILL GAS COLLECTION AND TREATMENT ALTERNATIVES

3.5.1 G1 – No Further Action, Utilize the Existing Gas Collection System

This alternative involves the continued utilization of the existing passive gas vent system at the Site (shown on Figure 4). Repairs to the existing gas flares may be required in order to maintain the gas collection efficiency of the system. The following estimated costs are associated with utilizing the existing gas collection system:

- Capital Cost $227,500
- Annual O&M $50,000
- Total Present Worth(30 yrs @ 5%) $996,100

3.5.2 G2 – Supplement the Existing LFG System

The existing passive flare system in the new landfill area, consisting of flares GWF1-GWF14, would be repaired, as necessary, and continue to be operated. LFG collection and treatment would also be supplemented through the addition of an active system in the old landfill section, consisting of approximately five new vertical extraction wells (GE1-GE5), and utilization of the nine existing extraction points (LP1-LP4, and LP10-LP14). The extraction points would be interconnected by header piping to a blower/flare station. A pilot/predesign study would be undertaken to determine the necessary repairs to the existing passive flares in the "new landfill", viability of using the nine existing wells in the "old landfill" and the optimum locations for placement of new wells in the "old landfill". Figure 11 shows the system layout for this alternative.

The installation of this new system in the "old landfill" area would require trenching in areas of the Site where header pipe placement is needed (or this work would need to be coordinated with the "new landfill" cap re-construction, if performed), the placement of header piping and installation of the new wells, backfilling, the reworking of the cap, and construction of the blower and flare station.

After installation of the new system, operation, inspection, and maintenance would be required as described for alternative G3. The existing system in the "new landfill" area would also require inspection and maintenance. Construction activities would have to be staged so that they would not encroach upon or impact the adjacent wetlands or floodplain.

The following estimated costs are associated with this gas collection/treatment alternative:

- Capital Cost $714,150
- Annual O&M $35,000
- Total Present Worth (30 yrs @ 5%)..... $1,252,175

3.5.3 G3 – Active Site Upgrade of LFG System

Figure 12 illustrates the system layout for this alternative. Stick flares (GWF1-GWF14) in the "new landfill" area would be converted to extraction wells (as necessary). Existing vertical extraction wells in "old landfill" would be used, and additional wells in the "old landfill" would be installed (as needed). A header system would be installed that would interconnect all of the wells, including LP1-LP14, located throughout the landfill, to convey LFG to one centralized blower/flare station, forming an entirely active extraction and treatment system. As in the case of G2, a series of pilot/predesign studies would be conducted to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. The results of these pilot/predesign studies may indicate that the fully active system proposed under G3 is not necessary, and that G2 is sufficient to address the LFG at the Site.

The implementation of this alternative would require trenching in areas of the Site for pipe placement (or if cap construction occurs, placement of piping would be coordinated with that work), placement of pipe and new wells, placement of backfill around these new features, localized cap reconstruction and construction of the blower and flare station. Construction activities would be performed so they do not encroach upon or impact the adjacent wetlands or floodplain.

This LFG system upgrade would allow LFG to be actively extracted from the waste mass increasing the radius of influence (ROI) of each well to between 100 and 150 feet per well which is typical for active municipal LFG extraction wells. The existing 14 wells (GWF1-GWF14) are spaced approximately 200 feet apart, allowing for effective use of a 100 to 150 foot ROI. Approximately five new wells (GE1-GE5) would be constructed in the "old landfill" area and one new well (GE6) would be proposed for installation in the "new landfill" area to provide complete coverage. These new wells would have an approximate 35-foot depth and would be spaced approximately 200 feet apart. Approximately 12,000 feet of piping would connect all of the LFG extraction wells at the Site and a blower and flare station would be constructed.

This active gas system, after installation, would require continual operation and regular maintenance. Inspections would be performed monthly to assure proper operation of warning lights, telemetry systems, and building vents. Measurements of valve settings, pressures and blower settings would be recorded. Routine maintenance and LFG monitoring would be performed as well.

This active LFG extraction/collection system could be constructed as part of a dual extraction system for leachate and gas. An additional feature of this option would be leachate extraction, therefore the leachate collection portion of the dual extraction system is presented as leachate collection alternative LC3.

The following estimated costs are associated with this gas collection/treatment alternative:

- Capital Cost $910,000
- Annual O&M $50,000
- Total Present Worth $1,678,600

3.6 LEACHATE COLLECTION ALTERNATIVES

3.6.1 LC1 – No Further Action, Continue To Utilize Existing System

This alternative would utilize the existing toe-of-slope collection pipes and leachate extraction manholes. Collection of leachate would continue as it has, with approximately 1250 gpd removed from the landfill.

The following estimated costs are associated with this leachate collection alternative:

- Capital Cost $0
- Annual O&M $5,000
- Total Present Worth (30 yrs @ 5%).......... $76,860

3.6.2 LC2 – Toe-of-Slope Leachate Collection

Figure 13 illustrates the leachate collection system for alternative LC2. This combination passive/active leachate collection alternative involves extending the existing leachate collection piping along the perimeter of the waste mass on both sides of the separation barrier between the "old and "new" landfill areas, and using the leachate extraction wells (P1, P2A, P3A, and P8-P10) in the "new landfill" area. In the "new landfill" area, piping would be constructed along the north and south perimeters and would tie into the pipe which runs along the west side of the "new landfill" area into the east manhole (MHE). In the "old landfill" area, piping would be constructed along the north, south, and west perimeters that would tie into the pipe which runs along the east side into the west manhole (MHW). Approximately 4,200 feet of total piping would be placed.

Construction of this alternative includes removal of the cap in areas of pipe placement (or if cap construction occurs, placement of piping would be coordinated with that work), placement of backfill, relocation of excavated waste, and replacement of the cap. Construction activities would be staged so that they do not encroach upon or impact the adjacent wetlands and floodplain.

This alternative would increase leachate collection efficiency, reduce leachate levels near the toe of slope to eliminate seeps, and induce an inward gradient at the perimeter of the landfill, potentially capturing impacted shallow groundwater in the surficial sand aquifer in the vicinity of the Site. Extraction of leachate would continue via the leachate extraction wells in the "new landfill" and from MHE and MHW. In addition, the extraction points installed in 1993 (LP1-LP14) could be used. These 14 wells were constructed for leachate/gas extraction, if needed.

After construction of the new piping, routine operation and maintenance activities would need to be performed. Inspections would be performed to assure proper operation of pumps, switches, and alarms and equipment maintenance would be done, as needed. Monitoring of leachate volumes and composition would also be performed.

The following estimated costs are associated with this leachate collection alternative:

- Capital Cost $227,800
- Annual O&M $60,000
- Total Present Worth (30 yrs @ 5%)..... $1,150,120

3.6.3 LC3 – Upgrade/Supplementation of Leachate System

The layout for this alternative is shown on Figure 11. The toe-of-slope collection piping would be extended along the north and south perimeter of the "new landfill" only; existing extraction points in the "new landfill" would also continue to be used. A dual extraction system consisting of five new wells (GE1-GE5) interconnected with existing wells (LP1-LP4 and LP10-LP14) and header piped to a blower/flare station would be constructed in the old section of the landfill. A pilot/predesign study would be conducted to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. It should be noted that this alternative would be considered in conjunction with the LFG alternative G2, because the required construction for each of these alternatives is similar (i.e., use existing systems with minor upgrades in the "new landfill", install new wells in the "old landfill").

The work includes removal of the cap in areas of pipe placement (coordination of pipe placement and well installation would also have to be coordinated with the reconstruction of the cap), installation of additional leachate/gas extraction wells and header piping, backfilling, and relocating of excavated waste, and reconstruction of the cap. Construction activities would be performed so that they would not encroach upon or impact the adjacent wetlands or floodplain.

The "new landfill" area has six existing leachate extraction wells from which leachate can be pumped and discharged into a leachate holding tank. The collection pipe along the perimeter would act as a control measure to eliminate side slope seeps. This alternative would also induce an inward gradient at the perimeter of the Site, and shallow groundwater in the surficial sand aquifer in the vicinity of the Site.

After the systems are constructed, inspection, operation, and maintenance activities would need to be performed. For the "old landfill" area, inspections would be performed monthly for the gas and leachate systems to assure proper operation of warning lights, telemetry systems, building vents, pumps, and controls. The monitoring of valve settings, pressures, blower settings, and leachate volumes and composition would also need to be done. For the "new landfill" area, inspections would need to be performed monthly for the piping and pumps along with monthly monitoring of leachate volumes and leachate composition.

The following estimated costs are associated with this leachate collection alternative:

- Capital Cost... $345,550
- Annual O&M $72,000
- Total Present Worth (30 yrs @ 5%)..... $1,452,550

3.6.4 LC4 – Active Leachate Extraction

The system layout for this alternative is shown in Figure 14. It should be noted that this alternative would be considered in conjunction with the LFG alternative G3, because the required construction for each of these alternatives is similar (i.e., install new wells as necessary across the Site, install header piping and automate the entire system).

Existing gas and leachate wells (GWF1-GWF14 and LP1-LP14) located in both the old and new sections of the landfill would be converted to dual extraction wells. New dual extraction wells (GE1-GE6) would be constructed (as needed). A header system would be constructed for the conveyance of gas and leachate. Approximately 28 wells would require conversion into dual extraction wells and approximately 12,000 feet of header pipe installation would be required for leachate extraction. In addition to the leachate header piping, a leachate storage tank would be required (there is a tank currently on-site).

As in the case of LC3, a pilot/predesign study would be conducted to determine the viability of using existing extraction points and to identify new extraction points, if any, which may be needed. The entire system would be automated, and the final design would be based on the results of the pilot/predesign studies.

Construction of this alternative includes converting the existing gas wells into dual extraction wells, removal of the cap in areas of leachate header pipe placement (or if cap construction occurs, placement of header piping in coordination with that work), placement of pipe, backfilling and relocating excavated waste, reconstructing the cap, and installation of a leachate storage tank. Construction activities would be staged so they would not encroach upon or impact the adjacent wetlands or floodplain.

This alternative would increase leachate collection efficiency, reduce leachate levels throughout the landfill to eliminate seeps, and would also induce an inward gradient to control and collect shallow groundwater in the surficial sand aquifer in the vicinity of the Site.

After construction of this system, inspections would need to be performed on a monthly basis to assure proper operation of pumps, switches, controls, warning lights, telemetry systems, and building vents. Maintenance, adjustments, and repairs to the system would be made as necessary. Monitoring of leachate volumes and leachate composition would be performed in addition to the gas system monitoring that would be required (described in alternative G2).

The following estimated costs are associated with this leachate collection alternative:

- Capital Cost.. $403,500
- Annual O&M $60,000
- Total Present Worth (30 yrs @ 5%)..... $1,325,800

3.7 LEACHATE TREATMENT ALTERNATIVES

3.7.1 LT1 – No Further Action, Continue To Discharge To A Licensed POTW

Under this alternative, leachate would continue to be discharged to a licensed POTW. The leachate would be pumped directly from the collection system and transported or discharged to a POTW for treatment under an industrial discharge permit for the Site.

The following estimated costs are associated with this leachate collection alternative:

- Capital Cost.. $0
- Annual O&M $75,000
- Total Present Worth (30 yrs @ 5%)..... $1,152,900

3.7.2 LT2 – Pretreatment of Leachate, Discharge to POTW

Under this alternative, leachate would be pre-treated prior to discharge to a local POTW. Pretreatment may include chemical precipitation for metals removal and aeration to lower BOD concentrations. Table 3-1 indicates potential treatment processes for the removal of various compounds. The use of some combination of these pretreatment processes or discharge without treatment may be possible based on the requirements of the POTW.

An on-site pretreatment facility would require the construction of a treatment building; installation of tanks, piping, gauges, valves, fittings, pumps, electrical controls, and meters; and connection of utility service to the building. Construction activities would not encroach upon or impact the adjacent wetlands or floodplain.

This alternative would eliminate the hazards associated with overland transport of leachate to an off-site POTW, and would accommodate the increased volume of leachate associated with increasing leachate collection efficiency at the Site. The leachate collection alternatives presented previously are intended to bring about the reduction of leachate levels throughout the landfill.

Currently, approximately one gallon per minute (gpm) of leachate is pumped and transported to a POTW (1,500 gpd). The quantity of leachate removed would initially increase if an enhanced leachate collection system is installed at the site. For this alternative an initial increase in the extraction rate has been assumed. An agreement/permit with/from the local POTW would be required. The permit would specify the leachate constituent concentrations and acceptable leachate quantities that could be effectively handled by the POTW. A pretreatment facility would be designed and constructed to attain the pretreatment level required by the POTW, if necessary. Monitoring would be performed at the frequency specified by the POTW (no less than quarterly) to ensure compliance with the POTW's requirements.

After construction of this system, inspections would be performed on a monthly basis to ensure proper operation of pumps, switches, controls, warning lights, telemetry systems, and building vents. Maintenance, adjustments, and repairs to the system would be made as necessary.

The following estimated costs are associated with this leachate treatment alternative:

- Capital Cost $498,000
- Annual O&M $588,000
- Total Present Worth (30 yrs @ 5%)..... $9,528,000

3.7.3 LT3 – Treatment of Leachate, Surface Discharge

This alternative involves treatment of leachate to meet surface water discharge standards. A combination of multiple treatment technologies would likely be required to provide the necessary level of treatment to reduce all of the leachate constituents to required levels. Table 3-1 indicates potential treatment technologies for compounds typically found in landfill leachate.

An on-site treatment facility would require the construction of a treatment building; installation of tanks, piping, gauges, valves, fittings, pumps, electrical controls, and meters; and connection of utility service to the building. Construction activities would not encroach upon or impact the adjacent wetlands or floodplain. Operation and maintenance of the facility would require the services of a certified treatment plant operator for a minimum of 20 hours/week to operate, maintain and perform the required monitoring of the treatment systems.

A surface water discharge (NPDES) permit would be required for this alternative. Leachate would be extracted at a rate sufficient to control the off-site migration of leachate, treated, and discharged to a surface water location of adequate assimilative capacity. Since adjacent Sequiot Creek is not suitable for discharge due to its low assimilative capacity, another more remote surface discharge location would have to be identified for this alternative to be considered feasible. To demonstrate compliance with the NPDES permit requirements, monitoring at a frequency to be specified in the permit would need to be performed.

The treatment system would require continuous operation and ongoing routine maintenance. After construction of the system, inspections would, at a minimum, be performed on a monthly basis to assure proper operation of pumps, switches, controls, warning lights, telemetry systems, and building vents. Maintenance, adjustments, and repairs to the system would be made as necessary.

The following estimated costs are associated with this leachate treatment alternative:

- Capital Cost.. $1,912,000
- Annual O&M $635,000
- Total Present Worth (30 yrs @ 5%)... $11,673,000

3.8 GROUNDWATER ALTERNATIVES

3.8.1 Groundwater Monitoring

A groundwater monitoring plan would be implemented to assess the effectiveness of the existing or future remedial systems in reducing the contaminant impacts to groundwater. The groundwater monitoring program would monitor the quality of groundwater from both the surficial sand and the deep sand and gravel aquifers. A groundwater management zone (GMZ) cannot be established (in accordance with 35 IAC 620.250) because a contaminant plume requiring corrective action does not exist. In the event that a contaminant plume is discovered in the future, the need for establishing a GMZ would be reevaluated. Wells to be monitored would be selected based on the RI analytical results and their location relative to known groundwater flow directions (generally west, along Sequoit Creek, in the surficial sand aquifer, and southwest in the deep sand aquifer). Wells located along the south and southwest perimeter of the site would be likely candidates for inclusion in the groundwater monitoring plan, including:

G11S	US3S	G14D	W3D
G11D	US3D	R103	W4S
G14S	US4D	G102	W5S

The upgradient monitoring wells (G14S, G14D, G11S, and G11D) and the selected downgradient monitoring wells include wells which are screened in the surficial sand aquifer and wells which are screened in the deep sand aquifer at the Site. Monitoring wells US3D, US4D, and W3D form a linear downgradient monitoring network which is screened in the deep aquifer. Periodic sampling from this network of wells would be performed to gauge the effectiveness of remedial measures and document groundwater conditions in the vicinity of the site. (See Figure 15 for the location of the monitoring wells.)

The groundwater samples would be obtained from the selected wells periodically and would be analyzed for the current list of analytes which includes boron, chloride, iron, ammonia nitrogen, total dissolved solids, and zinc and would also be analyzed for VOCs. The monitoring program would be capable of recording changes in groundwater contaminant concentrations over time.

The following estimated costs are associated with groundwater monitoring:

- Annual Cost.. $95,600
- Total Present Worth (30 yrs @ 5%)..... $1,469,600

3.8.2 Contingent Groundwater Remediation

In the event that groundwater sampling results show a statistically significant increase in VOC concentrations associated with the Site, an appropriate response would be developed in a detailed corrective action plan. Corrective action could include: a thorough investigation of potentially impacted receptor wells, computer modeling to determine the potential aerial extent of impact, an aggressive remedial approach (such as well-head treatment via filtration and/or activated carbon), monitoring over the course of any needed remediation, and documentation of the completion of corrective actions.

To mitigate potential adverse environmental impact posed by groundwater contamination identified in the RI, the nearest public well, VW4, located in the industrial park, was replaced with a new well (VW7) which is located more than one mile from the site. As indicated previously, the costs already incurred for removing VW4 from service and installing VW7 are $693,900.

Details of the groundwater monitoring program including the exact wells to be sampled, a sampling schedule, etc. would be developed and proposed during the design phase for the Site.

The following estimated cost is associated with groundwater remediation:

- One-Time Cost $534,000

This cost includes a receptor survey, subsequent investigation, sampling and analyses, design, implementation, operation for 5 years, and reporting. The estimated cost assumes well-head treatment (such as activated carbon adsorption or ultrafiltration) would be implemented at up to three receptor locations.

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4.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

This section evaluates each remedial alternative presented in Section 3 with respect to seven of the nine criteria defined in the NCP in section 300.430(e)(9)(iii). Evaluation of each alternative's ability to satisfy the other two criteria, state/support agency acceptance and public acceptance, cannot be completed until public comment on the Proposed Remedial Action Plan has been received and evaluated. The purpose of this detailed evaluation is to determine how well each of the alternatives satisfies the remedial action objectives defined in Section 3 and the evaluation criteria mandated by CERCLA, and ultimately, to provide the information needed by the Agencies to make the appropriate risk management decisions.

4.1 CERCLA REQUIREMENTS

The statutory considerations embodied within Section 121 of CERCLA were assembled in NCP §300.430(e)(9) into the seven criteria that are to be used in the detailed evaluation of any remedial alternative. These seven criteria are:

- **Overall Protection of Human Health and the Environment** which addresses the degree to which a remedy provides adequate human health protection by virtue of how risks posed by each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- **Compliance with ARARs** addresses the degree to which a remedial alternative satisfies all of the applicable or relevant and appropriate requirements of other federal and State environmental statutes and/or provides the grounds for invoking a waiver of specific ARARs.

- **Long-Term Effectiveness and Permanence** refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met.

- **Reduction of Toxicity, Mobility, or Volume Through Treatment** is the anticipated performance of the treatment technologies which a remedy may employ.

- **Short-Term Effectiveness** addresses the time needed to achieve an adequate level of protection. It also evaluates any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until such time as the cleanup goals are achieved. Short-term effectiveness can be important in cases where one remedy can be implemented in a considerably shorter period than another remedy. In such a case, the former may be preferable, even if it provides a lesser degree of protection, since a significant level of protection is provided more rapidly.

- **Implementability** is the technical and administrative feasibility of a remedy, including the availability of the materials and services needed to complete a particular alternative.

- **Cost** includes estimated capital and long-term operation and maintenance costs, and also includes net present worth calculations.

In addition to these seven criteria, Section 121 of CERCLA provides for state involvement in remedy selection, and sections 113 and 117 provide for public participation during remedy selection. Under CERCLA, these two additional criteria (state involvement and public participation) are applied to the remedy selection process following receipt of Agency comments on the FS (for support agency acceptance) and after the public comment period following publication of the Proposed Remedial Action Plan.

The NCP §300.430(f)(1)(i) further divides these nine criteria into the following three categories:

- **Threshold criteria** which evaluate the overall protection of human health and environment provided by each remedial alternative

- **Balancing criteria**, which evaluate the anticipated costs, the degree to which each remedial alternative reduces toxicity, mobility and volume through treatment, the short-term effectiveness, and the ability to implement each alternative.

- **Modifying criteria**, which consist of state/support agency acceptance and public acceptance.

Each of the alternatives described in Section 3 is evaluated in terms of the threshold and balancing criteria in this section. Each evaluation is organized by capping, gas extraction, leachate collection and leachate treatment alternatives.

4.2 U.S. EPA GUIDANCE ON RISK-BASED DECISIONS

The U.S. EPA issued OSWER Directive 9355, 0-30 "to provide further guidance on how to use the baseline risk assessment to make risk management decisions such as determining whether remedial action under CERCLA Sections 104 and 106 is necessary". As stated in this Directive, U.S. EPA generally uses the results of the Baseline RA to establish the basis for taking a remedial action using either Section 104 or 106 authority. Under this Directive, U.S. EPA can "use the results of the Baseline RA to determine whether a release or threatened release poses an unacceptable risk to human health or the environment that warrants remedial action and to determine if a site presents an imminent and substantial endangerment."

The OSWER Directive provides specific guidelines for determining when remedial action is warranted, stating "where the baseline risk assessment indicates that a cumulative site risk to an individual using reasonable maximum exposure assumptions for either current or future land use exceeds the 10^{-4} lifetime excess cancer risk end of the risk range, action under CERCLA is generally warranted at the site. For sites where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, action generally is not warranted, but may be warranted if a chemical specific standard that defines the acceptable risk is violated or unless there are noncarcinogenic effects or an adverse environmental impact that warrants action." In addition, the Directive states that where the risk range at the Site is within the 10^{-4} to 10^{-6} range, the Record of Decision for the Site must explain why remedial action is warranted. Other than the risk ranges, maximum contaminant levels (MCLs) and non-zero MCL goals (MCLGs), where defined for specific chemicals, "may be used to define acceptable risk levels" and "to determine whether an exposure is associated with an unacceptable risk to human health and the environment and whether remedial action under Section 104 or 106 is warranted."

The Directive also states that the 10^{-4} upper boundary should not be considered a discrete line, but that "specific risk estimate(s) around 10^{-4} may be considered acceptable if justified based on site-specific conditions...Therefore, in certain cases EPA may consider risk estimates slightly greater than 1×10^{-4} to be protective."

The OSWER Directive explains that "if the baseline risk assessment and the comparison of exposure concentrations to chemical-specific standards indicates that there is no unacceptable risk to human health or the environment and that no remedial action is warranted, then the CERCLA Section 121 cleanup standards for selection of a Superfund remedy, including the requirement to meet applicable or relevant and appropriate requirements (ARARs) are not triggered. CERCLA section 121 (a) requires only that those remedial actions that are 'determined to be necessary ... under section 104 or ...106...be selected in accordance with section 121'." The Directive recognizes that even though a Site may not require remedial action under CERCLA, it still may be subject to action under a state or federal statute. The Directive states: "sites that do not warrant action under CERCLA section 104 to 106 may warrant action under another State or Federal statute, such as RCRA subtitle D requirements for the appropriate closure of a solid waste landfill."

4.3 NO FURTHER ACTION EVALUATION

As summarized in Section 1, the Site has an existing final cover (35 IAC 807 cover) over the old and new landfills, a leachate collection system, a landfill gas collection system and a groundwater monitoring program. These systems are in place and have been operational for the last nine years, since the Site closure was completed in 1988. Subsequent studies conducted at the Site include a comprehensive RI Report and a Baseline RA. The results from the Baseline RA indicate that there are risks which slightly exceed the 1×10^{-4} threshold in the off-site deep sand and gravel aquifer. However, the Baseline RA was not able to consider the beneficial impacts of the control measures already in place at the Site.

Therefore, the estimated risks are truly conservative, especially considering that the risk analysis was based solely on reasonable maximum exposure (RME) scenarios and not most likely exposure (MLE) scenarios.

The Baseline RA considered the results from the RI Report to determine if the Site posed risks which may exceed the 1 x 10^{-6} RME cancer risk threshold or a hazard index greater than 1. It is important to emphasize that the Baseline RA indicates that no constituent exceeded an RME hazard index greater than one, and that only three constituents posed a theoretical RME lifetime cancer risk greater than 1 x 10^{-6}. These three constituents include beryllium, arsenic and vinyl chloride. It should be noted that beryllium and arsenic are naturally occurring elements in groundwater near the Site.

Most significantly, the only cumulative pathway risk which exceeded an RME lifetime cancer risk of 1 x 10^{-4} was the hypothetical future use of the off-site deep sand and gravel aquifer. The cumulative risk for this potential future pathway was calculated to be 9 x 10^{-4} due to the presence of vinyl chloride. The Baseline RA considered the sample analytical results from off-site wells US03D and W03D to establish the risk associated with the vinyl chloride in the off-site deep sand and gravel aquifer. US03D was sampled twice during the RI and vinyl chloride was detected in the well at 28 and 35 µg/L. Samples collected from W03D did not exhibit detectable concentrations of vinyl chloride. Therefore, although two samples from US03D indicated vinyl chloride was present in the deep sand and gravel aquifer, data from W03D indicate that the extent of the vinyl chloride impact is quite limited. These two wells are approximately 600 feet apart. Well US03D is located downgradient of the landfill, in the Sequoit Acres Industrial Park. W03D is also located downgradient of the landfill, but is upgradient of the Sequoit Acres Industrial Park.

The Baseline RA utilized only two rounds of analytical data to establish this risk. The uncertainty regarding the presence of vinyl chloride in the deep sand and gravel aquifer is highlighted by the analytical data obtained over the course of the routine sampling of Village of Antioch well VW4, which was located approximately 120 feet west of US03D. Vinyl chloride, of unknown origin, had been detected sporadically in samples from this well over several rounds of sampling between 1984 and 1989. In the 24 subsequent monitoring rounds spanning the period from 1989 through 1994, vinyl chloride was not detected. The last detection of vinyl chloride in Village well VW4 was in a sample collected on August 23, 1989. The results also indicate a decreasing trend in the vinyl chloride concentrations over time (Table 4-1), with no measurable impacts over a period of five years. These facts argue persuasively that the vinyl chloride was an artifact of an incidental, non-recurring release, and do not indicate gradually deteriorating groundwater conditions that may be attributable to ongoing releases from landfilled wastes. Again, one must note that wells US03D and VW4 are located in an industrial park with documented filling activities as well as industrial and hazardous waste handling and storage operations.

The argument that the vinyl chloride does not represent a release from the Site is further reinforced by the fact that the two most likely primary receptors, the surficial sand aquifer and Sequoit Creek, fail to exhibit impacts from vinyl chloride and as such, do not pose unacceptable risks. Hazardous constituents migrating from the landfill mass must first discharge to the surficial sand aquifer and then intersect the Creek. The RI data indicate that these two most sensitive receptors have not been significantly impacted. Consequently, it is reasonable to assume that the downgradient impacts from vinyl chloride in the deep sand and gravel aquifer do not represent an ongoing release from the Site.

Arsenic was detected in samples collected from municipal wells VW-3 and VW-5 (2.1B μg/L and 4.5B μg/L, respectively), but based on background and downgradient data, arsenic is not a compound associated with the Site. The arsenic concentrations detected in these wells during the RI were well below the legally-enforceable MCL of 50 μg/L for arsenic. Furthermore, VW-5 is located much further downgradient of the Site than VW-3, yet exhibits the higher of the two concentrations of this contaminant. In summary, the risk associated with the arsenic detected in the municipal wells is within the range of acceptability (i.e., 9×10^{-5}), and the spatial distribution of the arsenic detections does not support the conclusion that the arsenic represents a Site-related release.

Beryllium, according to the Baseline RA, poses a cumulative RME excess lifetime cancer risk of 7×10^{-5} within the off-site surficial sand aquifer. However, beryllium was only identified as a compound of potential concern because RI background data for beryllium were not available. Beryllium was detected (at 0.95 μg/L) in only one out of four groundwater samples collected from the off-site surficial sand aquifer. It was also detected in only one out of 34 regional background samples at a concentration of 1 μg/L. Based on these facts, it is possible that these beryllium concentrations are naturally occurring within the surficial sand aquifer. Significantly, beryllium was not detected in samples obtained from the surficial sand aquifer on-site monitoring wells, and it can therefore be concluded that these detections are probably not associated with the H.O.D. Landfill. Furthermore, the surficial sand aquifer is of limited extent and is not used for drinking purposes. The installation of wells into the surficial sand for the purpose of obtaining drinking water is prohibited near the Site by 35 IAC which establishes setback requirements for drinking water wells placed near landfills.

It is clear that the significance of the risks identified in the Baseline RA is questionable. The landfill is now over 30 years old (filling began in 1963). The horizontal groundwater flow velocities in the surficial sand (4 to 215 feet/year) and the deep sand and gravel (3 to 8 feet/year) are such that groundwater impacts from the landfill would have been detected in off-site wells within the first several years of operation. The data presented in the RI and the Baseline RA do not support a determination that the Site poses a significant current or future risk to human health and the environment.

As mentioned earlier, the Baseline RA does not consider the fact that a landfill cover, leachate and landfill gas collection systems, and institutional controls have already been implemented or are already in place at the Site to further reduce the potential for releases to the environment.

Future private residential use of the deep sand and gravel aquifer is unlikely, given that the Village of Antioch has enacted an ordinance that requires properties within the Village limits to be connected to the public water supply. In addition, 35 IAC 811 also prohibits the installation of drinking water wells in the immediate vicinity of a known landfill.

In summary, only one pathway, the potential future use of the off-site deep sand and gravel aquifer exceeds the U.S. EPA's 1×10^{-4} threshold for remedial action under CERCLA section 104 or 106. However, given the fact that vinyl chloride has not been detected in VW4 since 1989, and the likelihood that the past detections of vinyl chloride represent an incidental non-recurring release probably attributable to a source within the Industrial Park, the risk estimate should be considered highly uncertain and conservative. Therefore, the risks associated with the Site may not warrant remedial action under CERCLA sections 104 and 106.

As stated in Section 4.2, even though a Site may not warrant remedial action under CERCLA, it still may be subject to action under a state or federal statute. Although this Site may not warrant CERCLA remedial action, it is regulated and has been closed under the State of Illinois Permit Program for solid waste landfills, and the applicable Illinois regulations still apply. The Site stopped accepting waste before October 9, 1993 and was originally closed under 35 IAC 807 requirements and, therefore, is exempt from the requirements of 35 IAC 814. Additionally, as stated in Section 2.2, under law, 35 IAC 807 is the only applicable and enforceable regulation governing post-closure care activities, specifically, for capping at the Site (see also City of Woodstock vs. Mary Gade and IEPA, Illinois Circuit Court, 19th Judicial Circuit, Gen. No. 96 MR 206).

Therefore, because under a no further action alternative the Site would revert back to the State Permit Program under 35 IAC 807, a brief description of the proposed actions under the State of Illinois Permit Program are presented below.

4.4 PROPOSED ACTIONS UNDER THE ILLINOIS PERMIT PROGRAM

Under the State of Illinois Permit Program, several actions would take place to bring Site conditions into compliance with the existing Illinois Operating Permit #1975-22-OP for H.O.D. Landfill.

To comply with the 35 IAC 807 regulations, the following will be done:

- The cap will be repaired with sufficient compacted clay and an appropriate vegetative layer such that it meets or exceeds the requirements of the existing 35 IAC 807 Permit.

- Leachate collection will continue, and will be automated as necessary to maintain the leachate levels and eliminate leachate seeps.

- Leachate will continue to be treated at a licensed POTW.

- The existing LFG system will be upgraded, potentially activating all or part of the existing system.

- Groundwater and surface water will continue to be monitored, with the possible expansion of the current system to include more wells or analytes.

- Village well VW4 will be taken out of service (already completed) and permanently sealed.

As discussed in Section 2, understanding the interrelationships between capping, LFG collection and treatment, and leachate collection and treatment is paramount in selecting an appropriate site remedy. Based on the conclusion of the Baseline RA, the driving risk at the Site is vinyl chloride in the deep groundwater. Therefore, if volatile compounds, including PCE, TCE, 1,2-DCE (all chemical precursors of vinyl chloride) and vinyl chloride can be reduced in the waste mass, the potential for dissolution into the groundwater can be significantly reduced. The most efficient way to reduce these compounds in the waste mass is by effectively collecting LFG and leachate at the Site. Minimization of infiltration is not a appropriate goal at this Site because of the identified Site characteristics: areas of the landfill were designed as "zone of saturation" (waste below the water table) fill areas. Therefore, leachate extraction and control will always be a component of the long-term O&M of the Site. Thus, minimization of infiltration will only be a small factor in the overall leachate maintenance program. In addition, an adequate landfill cap (repairing the existing cap to eliminate low areas, ponded water, and leachate or LFG seeps) will help to limit infiltration, and thus the production of leachate. However, it is recognized that with improved LFG and leachate collection, the importance and benefits of a completely reconstructed cap are significantly decreased. Therefore, by implementing the above-listed actions at the Site, LFG and leachate controls will be enhanced significantly, thereby reducing concentrations of VOCs in the waste mass.

Each of the above bulleted items proposed under the State Permit Program is described below.

Cap Repair

The "old landfill" area is covered with a continuous cap that is generally in excellent condition. No low spots, bare vegetation, leachate or LFG seeps have been noted in the "old landfill" area. Therefore, cap repair will focus on the "new landfill" area. The "new landfill" area will be repaired to re-establish the approximate Site grades that existed at the time of Site closure in 1988. This grading will control infiltration, and promote positive drainage. Areas where leachate seeps have been noted will be overexcavated and backfilled with compacted clay, effectively sealing the landfill cover. To minimize erosion, the cap will have a vegetative cover and a continuous sloped surface consisting of a 2% minimum slope that will promote positive and continuous drainage. The side slopes in the "new landfill" portion of the Site will regraded such that they are 33% maximum and will be repaired, as needed. The cap will allow for a maximum average annual infiltration rate of no greater than 2.48 inches per year (based on the HELP model for the 35 IAC 807 compliant cap) and will be repaired in a fashion that will facilitate the post-closure care goal of minimizing further cap maintenance. By controlling infiltration, potential for leachate seeps will be reduced.

Leachate Collection and Treatment

The leachate collection system will also be automated in order to maintain leachate levels at the "leachate maintenance level," defined in the existing operational permit to be two feet below the water level elevation contemporaneously measured in well G11D. Existing materials (wells and header piping) will be used to the fullest extent possible to minimize costs and time required to implement this remedial action. The installation of leachate pumps could be considered for existing monitoring wells and extraction points within the waste mass. Leachate extraction of specific points at the Site could be evaluated to address leachate seeps.

Leachate removal will be increased from the current maximum rate of approximately 1 gallon per minute to a rate necessary to maintain the leachate maintenance level. An estimated steady-state rate of 5.25 gallons per minute is anticipated after an initial start-up period when leachate extraction volumes may be higher. To accommodate the increased leachate volume, two options will be evaluated: (1) pretreatment and discharge to a POTW, and (2) direct discharge to a POTW.

Landfill Gas Collection and Treatment

The existing LFG extraction system will be upgraded to an active system to more efficiently collect LFG and to reduce the partitioning of VOCs to groundwater. A pilot study will be conducted to determine if activation of part or all of the existing LFG system is necessary. If the system requires activation, the individual wells would likely be connected with a header pipe to a single flare point and automated in order to monitor/quantify the mass of VOCs removed from the Site. Radii of influence exerted by extraction wells (assumed to be 100 feet, pending pilot study verification) will be sufficient to account for current and future LFG volumes across the entire Site. Existing materials (wells) will be used to the fullest extent possible to minimize costs and expedite the implementation of this remedial action.

Monitoring

The current groundwater and surface water monitoring system in place at the Site will continue to be used to ensure the landfill is not detrimentally affecting the surrounding groundwater and surface water. It is probable that additional monitoring points will be established, and additional analytes will be monitored on a routine basis.

Elimination of Village Well VW4

As described in Section 1, VW4 has been taken out of service and replaced with VW7, which is further away from the Site (Figure 6). The Village of Antioch has no further plans to install more wells in the vicinity of the Site, and is not able to use the water from VW4 for drinking water supply. VW4 will be permanently sealed, contingent on the approval of the Village of Antioch.

Institutional Controls
Institutional controls such as deed restrictions, site fencing, access restrictions, and warning signs will be used to implement institutional controls at the Site. In addition, the Village of Antioch ordinance requiring properties to connect to the public water supply will serve to virtually eliminate the potential use of the aquifers near the Site.

4.5 EVALUATION OF ALTERNATIVES

The remedial actions described above were developed after consideration of several discrete remedial options. In order to select appropriate specific remedial actions at the Site, several alternatives for capping, landfill gas collection and treatment, and leachate collection and treatment, were evaluated, and are presented herein, to facilitate review and evaluation of the post-closure care requirements. This alternatives evaluation compares potential post-closure care alternatives against seven of the nine criteria defined in the NCP in section 300.430(e)(9)(iii). It should be noted that regardless of which remedial alternatives are selected, they would be equally implementable under either CERCLA or the Illinois State Solid Waste Program.

4.5.1 Capping Alternatives Evaluation
The capping alternatives consist of: C1 - Repairing the "new landfill" area cap to comply with the existing closure/post-closure plan; C2 - Reworking the existing cover to form an 807-compliant cap; C3 - Supplementing the existing cover to form an 811-compliant cap.

4.5.1.1 Overall Protection of Human Health and Environment. Alternative C1 - As previously discussed in Section 1.6, the Baseline RA demonstrated that the only risk to human health and the environment potentially associated with the Site is that posed by the possible ingestion of vinyl chloride from the off-site deep sand and gravel aquifer. Repairs to the cap would not further reduce the specific risk posed by vinyl chloride since a repaired cap would not directly mitigate the possibility of ingestion of vinyl chloride from the off-site deep aquifer. The existing cap has been proven over time to provide adequate protection to human health and the environment by preventing dermal contact with landfill contents, reducing contaminant leaching to groundwater, controlling surface water runoff and erosion, and reducing the potential for direct inhalation of LFG by providing increased containment for LFG. In order to ensure that the adequate level of protection of human health and the environment provided by the cap is maintained, the existing cover on the "new landfill" area would require repairs which would involve regrading the low areas on Site, and recompacting cover soils to repair leachate seeps and to produce a continuous cap. In this manner, the "new landfill" area would be brought up to existing permit standards. The cap repairs would reduce storm water infiltration to approximately 2.48 inches/year, thereby reducing leachate production. A decrease in leachate production over time would help reduce leachate head levels within the Site thus meeting the remedial action objectives presented in the "presumptive remedy for CERCLA Municipal Landfill Sites" Guidance.

Alternatives C2 and C3 - As previously mentioned, the only risk to human health and the environment associated with the Site is that posed by the possible ingestion of vinyl chloride from the off-site deep aquifer. The cap improvements prescribed under Alternatives C2 and C3 would not further reduce the specific risk posed by vinyl chloride because improvements would not eliminate ingestion pathway consideration, as in the case of Alternative C1. It is also important to note that augmenting the existing cap structure could exacerbate environmental threats posed by LFG, as discussed in Section 2.3.3. A much "tighter" cap could increase the rate of partitioning of LFG constituents into leachate and groundwater, thus elevating the potential level of risk associated with the Site. As a result, Alternatives C2 and C3 would elevate risk levels above those associated with Alternative C1. Alternative C3 would be the "worst case" alternative for this reason; also, Alternative C3 could introduce further risks because it would involve the manipulation of cover materials on a much larger scale than the other two alternatives. Benefits provided by Alternatives C2 and C3 would include preventing direct contact with landfill contents, reducing contaminant leaching to groundwater, controlling surface water runoff; however, all of these benefits could be achieved with far less risk by making simple repairs to the cap, as described under Alternative C1. Reworking the existing cover for both Alternative C2 and C3 would involve regrading of the site prior to recompaction of the barrier layer of the cap and placement of the cover soils. Both alternatives would reduce rainfall infiltration through the cap slightly more than Alternative C1 (an estimated maximum of approximately 1.9 inches/year and 2.1 inches/year for Alternatives C2 and C3, respectively), as modeled by the HELP model Version 3 (see Appendix B) and ultimately would reduce leachate head levels within the waste mass.

It is important to note that since a portion of the Site was constructed with the base of the landfill below the water table (a "zone of saturation" Site), reduction of infiltration alone will not prevent leachate generation. Therefore, a balance between the capping alternative and the leachate collection alternative must be considered when selecting the Site remedial components. Capping alternatives C2 and C3 do reduce infiltration slightly more than C1, but because leachate generation and collection will be required regardless of what cap alternative is selected, this slight infiltration improvement does not translate to greater protectiveness of human health and the environment.

4.5.1.2 Compliance with ARARs. ARARs that apply to capping alternatives involve protection of the floodplain, wetlands, and surface waters, and compliance with 35 IAC 807 requirements. Capping alternatives C1, C2, and C3 all comply with the applicable State 35 IAC 807 requirements (Alternative C3 also complies with 35 IAC 811, which does not appear to be applicable nor appropriate, as discussed in Section 2.2.3) by addressing cover design and performance by providing, at a minimum, a two-feet thick low-permeability layer of compacted soil overlain by adequate cover soils to minimize erosion and maintenance requirements. All of the alternatives involve regrading to remove surface irregularities, thus controlling surface water runoff and protecting Sequoit Creek. All of the alternatives would involve erosion control and staged construction activities such that the adjacent wetlands and floodplain would be protected.

4.5.1.3 Long-Term Effectiveness and Permanence. Alternatives C1, C2, and C3 address long-term protection by controlling stormwater infiltration into the landfill, thus decreasing the potential for contaminant transport into the leachate and groundwater. These alternatives, which combine both access restrictions and improved covers, would prevent direct contact with landfill contents. They would also minimize future erosion and control surface water runoff by implementation of the maintenance plan described for each alternative. The soil cover of each of the alternatives can last indefinitely if correctly maintained.

4.5.1.4 Reduction of Toxicity, Mobility or Volume Through Treatment. Capping alternatives do not involve treatment and therefore cannot be evaluated against this criterion.

4.5.1.5 Short-Term Effectiveness. The potential short-term impacts on the community, environment, and construction workers during site construction activities were evaluated. These potential impacts include noise, dust, erosion, dermal contact with waste, and increased truck traffic.

Alternative C1 would have relatively low short-term construction impacts. These impacts may include additional noise and dust generation due to soil relocation/placement during cap regrading and waste consolidation. Since this alternative would primarily involve regrading and recompacting areas of the upper layer of the existing cap, dermal contact with the waste mass should not be a concern. Construction activities would be performed in accordance with agency-approved site health and safety plans. Potential dermal contact with the waste mass would be minimized through the use of personal monitoring and protective equipment (if necessary). Equipment decontamination would be implemented, thus further reducing the potential concern for dermal contact. Noise levels increase during construction; however, noise can be minimized by maintaining noise control devices on construction equipment. Wearing hearing protection can also reduce the effects of heavy machinery noise on site workers. Fugitive dust emissions would occur during construction; however, measures can be taken to minimize the amount of dust generated by the watering of construction areas and roads, and the potential use of dust masks by site workers. Additionally, erosion control measures and protection of Sequoit Creek from sedimentation would be conducted during construction and thereafter, as needed. This alternative would take approximately four weeks to construct based on moving approximately 6,000 cy of material per day, six days per week (Appendix A).

Alternative C2 would also have relatively low short-term construction impacts. These impacts may include potential dermal contact with waste, and additional noise and dust generation due to soil relocation/placement and waste consolidation during cap construction. Construction activities would be performed in accordance with agency-approved site health and safety plans, which would include personal monitoring, protective equipment (if required), and equipment decontamination recommendations and therefore would reduce the potential concern for dermal contact. Noise levels increase during construction; however, noise can be minimized by maintaining noise control devices on construction equipment. Wearing hearing protection can also reduce the effects of heavy machinery noise on site workers. Fugitive dust emissions would occur during construction; however, measures can be taken to minimize the amount of dust generated by the watering the construction area and roads, and the potential use of dust masks by site workers. Additionally, erosion control measures and protection of Sequoit Creek from sedimentation would be conducted during construction and thereafter, as needed. This alternative would take approximately 17 weeks to construct based on moving approximately 6,000 cy of material per day, six days per week (Appendix A).

Alternative C3 would have some short-term construction impacts, including increased dust, noise, and the potential for dermal contact with waste. As stated above for Alternative C2, measures can be taken to minimize all of these construction impacts. This alternative may also involve importing supplemental clay to complete the compacted clay cap. Therefore, an increase in truck traffic, noise, and dust generation could be expected during the construction period, which could affect nearby community roads. Construction is expected to take 22 to 27 weeks and may extend over the course of two construction seasons. If a clay borrow site is needed, it would also experience short-term construction impacts requiring dust control, noise control, erosion control, and surface water management. These impacts would be addressed using the same measures outlined above to minimize impacts at the H.O.D. Site.

4.5.1.6 Implementability. Alternatives C1 and C2 would require the coordinated work of an earthwork contractor with a landscape subcontractor. Alternative C1 could be implemented with a minimum of earthwork activity, limiting the activity to the low areas of the Site only. Alternative C2 would require more disturbance of surface soils, and therefore more earthwork and compactive effort. Under either alternative, no off-site materials would be required to complete the cap construction. Earthwork contractors with landfill capping experience are readily available in the area of the Site. An agreement with the adjacent property owner would be necessary for access to consolidate the off-Property waste at the northern edge of the "old landfill" onto WMII property. Both C1 and C2 could be implemented in one year.

Alternative C3 would involve the coordinated work of an earthwork contractor with a landscape subcontractor. A clay source would likely be required which can provide clay meeting the quantity needs and quality specifications established for the Site. Approximately 103,000 cy of quality clay meeting the maximum permeability of 1×10^{-7} cm/s would be required to construct a three-foot thick barrier layer. Prior to transporting any off-site clay, weight restrictions and other local road requirements would need to be evaluated. An agreement with the adjacent property owner would be required for access to consolidate the off-Property waste at the northern edge of the "old landfill" onto Site property. C3 may require two construction seasons to implement the entire capping remedy.

4.5.1.7 Costs. Table 3-2 indicates costs for the capping alternatives. Costs include present worth of capital and Operation and Maintenance (O&M) costs. The detailed cost estimates are contained in Appendix C. Alternative C1 is estimated to cost approximately $2.8 million dollars, and reduce infiltration by approximately 2 inches per year (to approximately 2.48 inches per year). Alternative C2 will cost approximately $6.9 million dollars, and only reduce infiltration by an additional one-half inch, or by 2.5 inches per year (to 1.9 inches per year). In other words, if C2 was implemented, the additional $4 million would only reduce infiltration by an additional one-half inch. C3 will potentially cost from $9.2 to $11.6 million dollars, depending on the use of existing clay, and will actually be less effective than C2, reducing infiltration to 2.1 inches per year. Therefore, C1 is the most cost effective capping solution, by having the greatest impact on infiltration control for the least cost.

4.5.2 Gas Collection and Treatment Alternatives Evaluation

The gas collection/treatment alternatives consist of: G1 - Utilizing the existing passive gas vent system ("new landfill"; G2 - Upgrade and/or supplement the existing LFG collection system ("new landfill" (passive); "old landfill" (active)); and G3 - Install and activate the entire LFG system ("new" and "old landfill").

4.5.2.1 Overall Protection of Human Health and Environment. The risks posed by LFG from the Site are attributable to the potential for direct inhalation of LFG and partitioning of LFG constituents, including vinyl chloride, to groundwater. However, it should be noted that the RME excess lifetime cancer risk attributable to inhalation of VOCs from the ambient air at the Site falls well below the 1×10^{-6} threshold (the calculated risk is 4×10^{-9}), and therefore is considered acceptable.

Alternative G1 proposes utilizing the existing passive gas vent system for the entire landfill. This system has been demonstrated over time to be somewhat effective in venting and flaring LFG, but is not totally effective due to flare blow-out, and corrosion of the vent / flare stacks. If the system is used as originally intended (venting and flaring the LFG on a consistent basis) and is properly maintained, the existing passive system meets the remedial action objectives, and reduces risk to human health and the environment by preventing inhalation of vapors and controlling migration of LFG.

Alternative G2 provides for active extraction of LFG in the "old landfill" area only. The "new landfill" area would continue to use the existing system, following necessary repair of the existing wells and stick flares. If the existing system in the "new landfill" area were used as originally intended and maintained, coverage and efficiency in the "new landfill" area would be provided, along with increased protection from LFG migration or inhalation of vapors. Operation of the existing system in the "new landfill" and a new active system in the "old landfill" area would reduce risk to human health and the environment. This alternative could also be implemented with leachate collection alternative LC3, installation of an active leachate collection system in the "old landfill."

Alternative G3 proposes an active gas extraction system with a treatment flare for the entire landfill. This alternative assumes each installed well has a radius of influence of between 100 and 150 feet, and therefore provides adequate site coverage. LFG would be collected by the wells and piping and would be discharged to a flare system for destruction. This alternative meets the remedial action objectives and reduces risk to human health and the environment by preventing inhalation of vapors and controlling migration of LFG. This alternative would provide the added benefit of further reducing the concentrations of volatile organic contaminants in the leachate by removing them before they partition into the liquid phase. This alternative could also be implemented with leachate collection alternative LC4, installation of a dual extraction system.

4.5.2.2 Compliance with ARARs. The State of Illinois, under 35 IAC 807.502, requires a LFG management system that controls, minimizes, or eliminates post-closure release to the atmosphere to the extent necessary to prevent threats to human health or the environment. The State has promulgated specific air emission standards for LFG venting and gas collection systems. State of Illinois regulations (35 IAC Part 218) require that VOC emissions from the Site must not exceed 25 tons/year, because the Site is located in an ozone non-attainment area. Other pertinent State of Illinois air emission standards regulate particulate matter, sulfur, organics, carbon monoxide, nitrogen oxides and hydrogen sulfide (35 IAC Parts 212 - 217). There are also general provisions for the control of gas emissions.

Alternatives G1 would comply with the above-mentioned ARARs only if the existing system was repaired so that it could be operated as originally intended, and maintained so that it could be operated continuously. This alternative, because it relies on dated technology (passive stick-type flares), may not be as efficient at managing LFG emissions.

Alternative G2, which combines the dated passive stick flare technology in the "new landfill" area, and an active system in the "old landfill" area, would potentially meet the ARARs if the "new landfill" system was repaired and maintained so that it could be continuously operated. However, the dated technology used in the "new landfill" may not be as efficient for controlling LFG emissions.

Alternative G3 satisfies the accepted presumptive remedy objectives for landfill gas management, which is gas collection and treatment. This alternative would satisfy 35 IAC 212 through 218 requirements through active gas control and treatment and would include monitoring to ensure continued compliance.

4.5.2.3 Long-Term Effectiveness. Alternative G1, if maintained and operated continuously, could potentially provide long-term effectiveness. Over the years, LFG generation would decline and the LFG extraction system, if maintained, would continue to perform. The "old landfill" portion of the site is approximately 30 years old and gas generation is likely declining. The "new landfill" portion of the site is approximately 13 years old. LFG generation in this area of the Site is also declining, although it remains greater in this area than in the "old landfill". If the existing system were repaired and operated continuously, LFG in both areas could potentially be effectively controlled by this alternative.

Alternative G2, because of the use of the passive stick flare technology in the "new landfill" area, would potentially provide reduced long-term effectiveness, because there is evidence that the existing passive system used for LFG control in the "new landfill" area is not controlling landfill gas completely, and the "new landfill" area would be producing a greater quantity of LFG for a longer period of time than the "old landfill" area. However, if the existing system were repaired and operated continuously, this alternative would potentially control LFG emissions from the Site.

Alternative G3 provides increased long-term effectiveness. This alternative provides active extraction of LFG, thereby reducing the VOC concentrations within the waste mass. This active system utilizes RACT for control of LFG, and would be effective at eliminating LFG emissions from the Site.

4.5.2.4 Reduction of Toxicity, Mobility or Volume Through Treatment. All of the alternatives reduce the volume of LFG via combustion. Alternative G1 utilizes the existing stick flares. These flares can be affected during periods of low gas flow, or under high winds. Keeping these flares lit requires increased monitoring and O&M. G2 uses a combination of passive and active control for LFG, incorporating both the benefits of an active system and the increased maintenance issues associated with G1. Alternative G3 would use an active system to collect LFG from the entire waste mass and would feature combustion at a single point flare, allowing for less labor-intensive O&M. Reduction in toxicity through treatment would be addressed by G1, G2, and G3 provided the flares would stay lit. However, any of the alternatives could allow for periods of time when flares become extinguished and LFG can escape uncontrolled.

4.5.2.5 Short-Term Effectiveness. The potential short-term impacts from Alternative G1 include minimal disturbance of the Site during repairs to the existing system. Both G2 and G3 involve the installation of LFG header piping and the potential installation of additional gas extraction wells and a blower/flare station. This work would result in an increase of noise, dust, and the potential for dermal contact with waste by construction workers. Measures can be taken to minimize dust and noise, as previously discussed. Personal protective equipment and decontamination of equipment can reduce the potential for dermal contact and inhalation.

4.5.2.6 Implementability. Alternative G1 has already been implemented and would not require additional work beyond repair of existing vents, where necessary, and typical upkeep and periodic replacement of the existing vents and flares (as needed). Operation and maintenance activities (inspections of flares) for this LFG system are many and frequent; however, they are also easily performed.

Alternatives G2 and G3 would involve coordination of earthwork contractors and gas extraction system installation specialists. Materials required for the LFG system construction (piping, blower, flare, fittings, etc.) are readily available, as are the qualified contractors and subcontractors needed to perform the work. Operation and maintenance activities (inspections of flares, settings, controls, telemetry systems) for these LFG systems are required; however, they are also easily performed.

4.5.2.7 Costs. Present worth costs of the estimated capital and long-term O&M activities associated with LFG control alternatives are shown in Table 3-2. The detailed cost estimates for these alternatives are presented in Appendix C. The long-term costs of alternatives G1 and G2 are approximately the same, $1.2 million dollars. The difference between these two alternatives would be that G1 would cost more to operate and maintain, while G2 would cost more in capital expenditures, but less for O&M. G3 would cost approximately $1.7 million, because of the increased cost of capital improvements, but would also be the easiest system to maintain and the most reliable system. Alternative G3, because of the increased reliability and effectiveness of a totally active system, and because the additional costs to install a totally active system are relatively minimal (compared with the benefit and reliability of the system), is the most cost effective alternative.

4.5.3 Leachate Collection Alternatives Analysis

The leachate collection alternatives consist of: LC1 - No further action - Utilize existing system; LC2 - Toe-of-slope leachate collection; LC3 - Upgrade and/or supplement existing system; and LC4 - Active leachate extraction .

4.5.3.1 Overall Protection of Human Health and Environment. Alternative LC1 would utilize the existing collection pipes and leachate extraction manholes. Collection of leachate would continue as it has, with approximately 1500 gallons per day (gpd) removed from the landfill. This alternative would not provide additional leachate collection, and would not directly address leachate seeps from the landfill side slopes. However, based on the results of the Baseline RA, the leachate seeps do not pose an unacceptable risk to human health or the environment.

LC2 extends the existing toe-of-slope leachate collection piping in both the "old" and "new landfill" areas. The extended toe-of-slope drains would be installed several feet below the soil cover/waste interface, but would not be installed at the base of the waste. The object of this system would be to maintain the "leachate maintenance level" in accordance with the Site Operational Permit. These additional collection pipes, in conjunction with a repaired or upgraded cap, would actively control leachate seeps on the side slopes of the facility.

Alternative LC3 proposes extension of the existing toe-of-slope collection piping and use of the existing leachate extraction wells in the "new landfill" area. In addition, five new leachate extraction wells (to be installed as part of this alternative) and the existing leachate piezometers, if necessary, will be used for leachate extraction in the "old landfill." Leachate levels within the "new landfill" area would not be expected to significantly decrease under this alternative, although they would be maintained at or below the "leachate maintenance level." This would achieve containment by inducing an inward gradient, which is consistent with the original design of the Site.

Alternative LC4, active extraction of leachate, provides a system in both the "new landfill" and "old landfill" to actively pump leachate from the entire waste mass. By actively extracting leachate from within the waste mass and maintaining an inward gradient, shallow groundwater in the immediate vicinity of the landfill perimeter would be captured. This active system would increase leachate collection volumes and control leachate head levels within the Site. By reducing head levels and maintaining the "leachate maintenance level" within the waste mass, the potential for leachate migration would be reduced and the potential impacts due to infiltration through the cap would be minimized. Capture and control of shallow groundwater from the on-site surficial sand aquifer (as part of the active leachate collection) would result in an increased margin of safety for protection of human health and the environment.

4.5.3.2 Compliance with ARARs. The State of Illinois requirements for landfill leachate collection include specific standards requiring control, minimization, or elimination of leachate releases to the groundwater and surface water to the extent necessary to prevent threats to human health and the environment. Although the Baseline RA indicates that risks posed by the leachate seeps at the Site are acceptable, these leachate seeps are considered unacceptable under the 35 IAC 807 requirements. If not already addressed by the landfill cap repair, leachate seeps may continue and LC1, which does not directly address leachate seeps, may not comply with ARARs.

LC2, which would add the toe-of-slope leachate drains, would actively control the leachate seeps, but the potential for leachate breakouts or migration to the groundwater, due to the volume of leachate remaining in the landfill, would still be present. LC2, therefore, would be questionable with regard to ARAR compliance.

LC3, which would utilize both automated and manual methods to control leachate appears to comply with the ARARs because the potential for leachate seeps in the "new landfill" is addressed, but the potential for migration to groundwater in the "new landfill" would still exist.

LC4, active collection of leachate from the entire landfilled waste mass, would comply with ARARs by eliminating the potential for leachate seeps, and significantly reducing the likelihood of leachate migration to the groundwater.

4.5.3.3 Long-Term Effectiveness. Alternative LC1 would not collect more leachate than is now being collected. Therefore, the increased effectiveness of this alternative for controlling leachate seeps and migration to groundwater would be minimal.

Alternative LC2 would result in an increase in leachate collection quantities in the short term, and also in the long term, if properly maintained. The leachate mound within the waste mass would likely remain, although the potential for seeps would be minimized. This alternative would be somewhat effective in the long-term for minimizing leachate migration to groundwater.

Alternative LC3 also represents an increase in long-term effectiveness, because leachate levels would be controlled within the waste mass in the "new landfill" area. However, the leachate levels would still remain in conformance with the requirements of the IEPA permit for the Site and the current total pathway risk from leachate seeps has been calculated to be well within acceptable limits. However, the minimization of leachate migration to groundwater is not generally addressed by this alternative.

Alternative LC4 would increase leachate collection quantities in the short term, and if maintained, should continue to operate effectively for many years. This increased leachate extraction would reduce leachate levels in the landfill and control the formation of leachate seeps. The reduction of leachate volume within the waste mass would serve to minimize the potential for migration of leachate to groundwater.

4.5.3.4 Reduction of Toxicity, Mobility or Volume Through Treatment. Although active collection of leachate does reduce the mobility and volume of leachate within the landfill waste mass, toxicity, mobility and volume of contaminants are not addressed. Therefore, this criterion is not applicable for leachate collection systems.

4.5.3.5 Short-Term Effectiveness. Because LC1 uses the existing system, no short term impacts are anticipated. The short-term impacts associated with the installation of leachate collection alternatives LC2 through LC4 would include increased dust, noise, and the potential for dermal contact with contaminants.

All three alternatives LC2, LC3, and LC4 would result in increased noise and dust during construction. In addition, the potential exists for construction workers to have dermal contact with contaminants. Personal protective measures can be taken to minimize these impacts, as discussed previously.

4.5.3.6 Implementability. The equipment used for LC1 already exists, and therefore this alternative would be easily implemented. Existing wells and manholes would continue to be used, and upgrades or repairs to these components would be easily made, if necessary.

LC2 would require the installation, via trenching and possible excavation, of corrugated perforated piping at the toe of the landfill slopes. This activity is a standard construction technique and would be readily implemented. Coordination with an earthwork contractor and potentially a subsurface utility (yard piping) contractor would be required. Materials necessary for the installation are readily available in adequate quantities.

LC3 would require installation of wells, installation of header piping, and construction of a blower and flare system in the "old landfill." Coordination of earthwork, utility, and mechanical, and electrical contractors would be necessary. Materials necessary to construct these components (wells, piping, pumps, fittings, blower, instrumentation, etc.) are all readily available. Operation and maintenance activities (inspections of pumps, fittings, controls, telemetry systems, and monitoring of leachate volume) would all be necessary and are also easy to perform.

LC4 would require construction similar to LC3, although it would be implemented in both the "old landfill" and "new landfill." Therefore, coordination of contractors and use of materials similar to those used for LC3 would be necessary, but on a larger scale. Materials and labor necessary to construct this alternative are readily available in sufficient quantity. Operation and maintenance of this alternative would be similar to that for LC3, but on a larger scale.

4.5.3.7 Costs. Estimated costs are included in Table 3-2 and include present worth of the one-time capital and long term O&M costs. The detailed cost estimates for these alternatives are presented in Appendix C. Alternative LC1, the lowest cost alternative, would cost approximately $200,000, the total of which is for long-term O&M. Alternative LC2 would cost approximately $1.15 million, of which $230,000 is for capital expenditures and the balance is for long-term O&M for pumping and labor. LC3 and LC4 would cost $1.4 and $1.3 million, respectively. Although the highest capital cost is associated with LC4 ($400,000), the less intensive O&M requirements for pumping and upkeep of LC4 ($920,000) make it more attractive than LC3, from a cost perspective. Therefore, because LC4 provides the greatest benefit (a fully automated leachate collection system with minimal O&M required) for $1.3 million, which is only marginally more expensive than the LC2 alternative, LC4 is the most cost-effective alternative.

4.5.4 Leachate Treatment Alternatives Analysis

The leachate treatment alternatives consist of: LT1 - No further action - continue to directly discharge leachate to a POTW; LT2 - Pretreatment of leachate, discharge to POTW; LT3 - Treatment of leachate, surface water discharge.

4.5.4.1 Overall Protection of Human Health and Environment. Alternative LT1 is currently operational at the Site. The leachate is pumped directly from the collection manholes, stored in a tanker truck, and transported to a POTW for treatment under an industrial discharge permit for the Site. This alternative is protective of human health and the environment, provided the leachate is discharged to the POTW in accordance with the industrial discharge permit.

Alternative LT2 proposes to pre-treat leachate onsite (if necessary) prior to discharge to a POTW. The leachate would be pre-treated to remove and/or reduce the concentrations of various constituents as required by the POTW (potentially BOD and metals, for example). The POTW would receive the treated water and complete the removal and/or reduction of concentrations of the remaining contaminants. This alternative would be protective of human health and the environment.

Alternative LT3 proposes construction of an on-site leachate treatment facility that would utilize various treatment technologies required to treat leachate to meet surface water discharge standards as required by a NPDES discharge permit. In order to implement LT3, easements, and rights-of-way would have to be obtained in order to construct the required piping from the treatment facility to the selected discharge point. Special property access rights would also have to be obtained, making this alternative the least implementable of the three. LT3 would protect human health and the environment, provided the NPDES limits were not violated.

4.5.4.2 Compliance with ARARs. The ARARs associated with all leachate treatment alternatives involve preventing release of leachate to groundwater or surface water. All three alternatives, if properly implemented, would comply with the general requirement to prevent discharge of leachate to groundwater or surface waters such that threats to human health and the environment are eliminated. In addition, alternatives LT1 and LT2 would have to comply with the applicable sewer discharge criteria, and POTW pretreatment standards, if implemented. Both these alternatives would comply with the sewer discharge criteria and POTW discharge standards, if properly implemented.

LT3 would be required to comply with the Clean Water Act, utilize best available technology to control pollutants, and properly operate the discharge system, including monitoring, maintenance, analyses, and establishing effluent standards. Alternative LT3 includes the complete treatment and discharge of leachate to surface waters. Again, such treatment would be implemented in compliance with applicable state and federal standards.

4.5.4.3 Long-Term Effectiveness. If properly maintained, any of the leachate treatment alternatives would provide long-term effective leachate treatment.

4.5.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. Each of the leachate treatment alternatives reduce the toxicity of the leachate by reducing and/or removing the contaminants of concern. Metals would possible remain as a treatment by-product (sludge or concentrate) to be disposed of appropriately. These metals would appear in the POTW sludge or in the on-site treatment system sludge. Toxicity would be reduced for the majority of the contaminants, and for metals, the mobility and volume of contaminant would be significantly reduced.

4.5.4.5 Short-Term Effectiveness. LT1 would require no additional disturbance of the Site, although the loading and transport of leachate would present noise and dust. Alternatives LT2 and LT3 could result in increased noise and dust during construction. Measures could be taken to minimize these impacts; for example, watering for dust control, the installation and maintenance of noise control devices on machinery, wearing noise protection equipment and wearing of dust masks.

4.5.4.6 Implementability. LT1 would be easily implemented, as the existing treatment is conducted at a POTW, following transport from the Site. The existing pumps could be used, and a tanker truck would be required to periodically transport the leachate, if a direct connection to the POTW is not permitted.

LT2 would require the construction of a pretreatment plant and ongoing monitoring to verify that required pretreatment standards are met. This pretreatment alternative would require an on-site treatment facility be constructed and treatment chemicals to be maintained on site. In addition, continued operation and maintenance of the pretreatment facility would be necessary.

LT3 would also require construction, management, operation, and maintenance of a leachate treatment plant. An NPDES permit would be required before the leachate treatment system could begin operation and discharge of treated leachate to a surface water body of adequate assimilative capacity. Operation and maintenance of this type of treatment plant would be intense and continual and would require ongoing monitoring.

4.5.4.7 Costs. Costs are included in Table 3-2 and include present worth capital and O&M costs. The detailed cost estimates for these alternatives are presented in Appendix C. LT1 would cost the least, approximately $1.15 million, all of which are O&M expenditures. Alternative LT2 would be the second most expensive, at $9.5 million. Approximately $500,000 would be required for the capital costs of the treatment system, and the majority of the LT2 costs ($9 M) are associated with O&M for the on-site treatment system. LT3 would cost anywhere from $9.8 million to $11.7 million, depending on a range of possible costs for the leachate treatment processes that could be required. Approximately $1.3 to $1.9 million would be required to build a treatment and discharge system for LT3 so that the treated leachate could be discharged using an NPDES permit. Given the excessive costs associated with construction and operation of an on-site treatment system and the relative ease of directly discharging to a POTW, alternative LT1, which is equally protective of the environment, and the most readily implementable of the three alternatives, is also the most cost effective.

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TABLES

Table 1-1
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Remedial Investigation - Leachate Samples
H.O.D. Landfill
Antioch, Illinois

Compounds	Groundwater Standards MCL	Class I	Class II	Sample Designation HD-LCLP01-01	HD-LCLP01-91	HD-LCLP06-01	HD-LCLP08-01	HD-LCLP11-01	HD-LCMHE-01	HD-LCFB01-01	HD-LCTB02-01
Detected VOCs											
Detection Limit				25	[illegible]	250	1,000	500	10	10	10
Vinyl Chloride	2	2	10						18		
Chloroethane				45	46						
Methylene Chloride	5	5	50	160	180	58			44	1	3
Acetone		700	700	110		2,200	19,000	1,500	140	13	5
1,1-Dichloroethene	7	7	35						5		
1,1-Dichloroethane		700	3,500						13		
1,2-Dichloroethene	70	70	200	7				190	70		
1,2-Dichloroethane	5	5	25						22		
2-Butanone				190		3,200	12,000	3,900	120		
1,2-Dichloropropane	5	5	25						28		
Trichloroethene	5	5	25						14		
Benzene	5	5	25	12	13				22		
4-Methyl-2-Pentanone				22	22	160	450		43		
2-Hexanone				14							
Tetrachloroethene	5	5	25	9					9		
Toluene	1,000	1,000	2,500	330	450	210	260	740	62		
Ethylbenzene	700	700	1,000	52	46			130			
Xylenes (total)	10,000	10,000	10,000	100	90	170		330	41		
Detected SVOCs											
Detection Limit				50	[illegible]	10	52	10	10	10	[illegible]
Phenol		100	100	160	170	83	840	5J	19		
1,4-Dichlorobenzene						5		20			
2-Methylphenol		350	350			16					
4-Methylphenol				730	760	1,300	2,200	48	5J		
2,4-Dimethylphenol		140	140	12J	11J	4J	20J	3J	6J		
Naphthalene		25	39		34J	6J	26J	16			
Diethylphalate		5,600	5,600	32J	31J			4J			
Di-n-butylphthalate		700	3,500							1J	
bis(2-ethylhexyl)phthalate		6	60					42			
Detected Pesticides/PCBs											
Detection Limit				1	1	1	1	1	1.1	1.1	[illegible]
Aroclor-1016		0.5	2.5	4.6	6.3						

Notes:
TICs not reported in Table; TICs results presented in Appendix O-7
Concentrations reported in micrograms per liter (ug/L)
J - Estimated value below detection limit
Samples collected on May 12-13, 1993

Table 1-2
Summary of Detected VOCs
Remedial Investigation - Landfill Gas Samples
H.O.D. Landfill
Antioch, Illinois

	[illegible] Designation													
Compounds	HD-LGLP01-01	DL	HD-LGLP0[illegible]-01	DL	HD-LGLP07-01	DL	HD-[illegible]-01	DL	HD-LGLP11-01	DL	HD-LGLP11-91	DL	HD-LGTB01-01	DL
Freon 12		4	6,300	80	1,800	400	2,100	400	9,100	400	8,600	200		
Chloromethane		5		6,000		500	720	500		500		250		
Freon 114		4	7,200	80		400	760	400	860	400	940	200		
Vinyl Chloride		5	4,900	100	21,000	500	13,000	500	1,100	500	1,300	250		
Chloroethane	47	10	810	200		1,000		1,000		1,000		500		
Freon 11	78	2	12,000	200	270	200		200	310	200	330	100		
cis-1,2-DCE	6.3	4	370	80	5,400	400	1,400	400	2,400	400	2,700	200		
Carbon Disulfide		20	690	400		2,000		2,000		2,000		1,000		
Acetone		20	730	400	3,900	2,000	15,000	2,000		2,000	520	1,000		
Methylene Chloride	95	8	220	160		800		800		800		400		
1,1-Dichloroethane		5	140	100	540	500		500		500		250		
1,1-Dichloroethene		4		80	480	400		400		400		200		
2-Butanone	21	6	1,800	120	5,200	600	22,000	600		600	600	300		
Benzene	10	6	420	120	970	600	670	600	630	600	690	300		
Trichloroethene		5	160	100	2,500	500	590	500	960	500	1,000	250		
Toluene	540	6	11,000	120	66,000	600	53,000	600	20,000	600	21,000	300		
Tetrachloroethene		6	270	120	4,400	600	830	600	2,700	600	2,800	300		
Chlorobenzene		5	180	100		500	4,500	500		500		250		
Ethylbenzene	34	5	3,700	100	11,000	500	9,700	500	3,200	500	3,400	250		
Xylenes (total)	52	10	7,600	200	30,000	1,000	24,000	1,000	7,000	1,000	7,100	500		
4-Ethyl toluene		8	520	160	1,300	800	2,600	800		800	490	400		
1,3,5-Trimethylbenzene		5	200	100	510	500	910	500		500		250		
1,2,4-Trimethylbenzene		6	440	120	1,200	600	2,100	600		600	420	300		

Notes:
Samples collected on June 4,1993
Concentrations reported in parts per billion
Only detected compounds reported
No compounds detected in Trip Blank
DL = detection limit

Table 1-3
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Remedial Investigation - Round 1 and 2 Groundwater Samples
H.O.D. Landfill
Antioch, Illinois

Round I Groundwater Sampling						Round II Groundwater Samping					
Sample Designation	Compounds					Sample Designation	Compound				
	Acetone	Carbon Disulfide	Vinyl Chloride	1,2-DCE	TCE		Acetone	Carbon Disulfide	Vinyl Chloride	1,2-DCE	TCE
MCL			2	70	5	**MCL**			2	70	5
Class I Std.	700	700	2	70	5	**Class I Std.**	700	700	2	70	5
Class II Std.	700	3500	10	200	25	**Class II Std.**	700	3500	10	200	25
G11S-01		0.8J				G11S-02		18			
G11D-01						G11D-02					
US01S-01						US01S-02					
US01D-01						US01D-02					
US03S-01						US03S-02					
US03I-01						US03I-02					
US03D-01			**28**	11		US03D-02			**35**	18	
US04S-01				35		US04S-02				44	
US04D-01						US04D-02					
US06S-01						US06S-02					
US06I-01					2J	US06I-02					1J
US06D-01						US06D-02					
W3D-01						W3D-02					
W3SB-01						W3SB-02					
W4S-01						W4S-02					
W5S-01			**19**			W5S-02					
W6S-01				2J		W6S-02					
W7D-01						W7D-02					

Notes:
Round I Groundwater Samples collected in May/June 1993
Round II Groundwater Samples collected in March 1994
Concentrations reported in micrograms per liter (ug/L)
J - estimated value below detection limit
SVOCs and Pesticides/PCBs were not detected in groundwater samples and are therefore not reported in the Table

Table 1-4
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Remedial Investigation - Private/Village Well Groundwater Samples
H.O.D. Landfill
Antioch, Illinois

	Groundwater Standards			Sample Designation (Round 1 Sampling)						
Compounds	**MCL**	**Class I**	**Class II**	**DL**	**VW3-01**	**VW5-01**	**PW1-01**	**PW2-01**	**PW3-01**	**PW5-01**
Detected VOCs										
Carbon Disulfide		700	3500	1		0.6J				
Detected SVOCs										
2-Methylphenol		350	350	5		0.5J		0.9J		
4-Chloroaniline				5	0.7J					

	Groundwater Standards			Sample Designation (Round 2 Sampling)			
Compounds	**MCL**	**Class I**	**Class II**	**DL**	**VW3-02**	**VW4-02**	**VW5-02**
Detected VOCs							
Acetone		700	700	5	11J		
cis-1,2-DCE		70	200	1		6J	
1,2-DCE		70	200	1	0.7J	0.5J	0.8J
Detected SVOCs							
2-Methylphenol		350	350				0.5J
4-Chloroaniline					0.7J		

Notes:
Concentrations reported in micrograms per liter (ug/L)
1,2-DCE - 1,2-Dichloroethene
J - Estimated value below detection limit
Round 1 Samples collected in June\July 1993
Round 2 Samples collected in March 1994 (Private wells not sampled during Round 2 activities)
Pesticides/PCBs were not detected in Private or Village Well Groundwater samples
DL = detection limit

Table 1-5

Summary of Analytical Results

Detected VOCs, SVOCs and Pesticides/PCBs

Remedial Investigation - Round 1 and 2 Surface Water Samples

H.O.D. Landfill

Antioch, Illinois

	Round 1 Surface Water Samples		
Detected VOCs	SWS101-01	SWS201-01	SWS301-01
2-Hexanone			3J
4-methyl-2-pentanone			2J

	Round 2 Surface Water Samples							
Detected VOCs	SWS101-02	SWS201-02	SWS301-02	SWS401-02	SWS501-02	SWS601-02	SWPSG1-02	SWPSG2-02
2-Hexanone								
4-methyl-2-pentanone								

Notes:
Tentatively Identified Compounds (TICs) not reported in Table
Concentrations reported in micrograms per kilogram (ug/kg)
J - Estimated value below detection limit
SVOCs and Pesticides/PCBs were not detected in Round 1 or 2 surface water samples
VOCs were not detected in samples other than SWS301-01
Round 1 Samples collected in May 1993
Round 2 samples collected in March 1994
The detection limit for all samples was 10 ug/l.

Table 1-6
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Remedial Investigation - Round 2 Sediment Samples
H.O.D. Landfill
Antioch, Illinois

	Sample Designation (Round 2 Sediment Samples)							
Detected VOCs	SDS101-02	SDS201-02	SDS301-02	SDS401-02	SDS501-02	SDS601-02	SDPSG1-02	SDPSG2-02
Detection Limit	520	1500	[illegible]	1100	490	690	2500	2100
Phenanthrene			310J					
Fluoranthene		380J	680J					
Pyrene		370J	580J					
Benzo (a) anthracene			250J					
Chrysene			300J					
bis(2-ethylhexyl)-phthalate		940J	1500J					
Benzo (b) fluoranthene			430J					
Benzo (a) pyrene			290J					

Notes:
Tentatively Identified Compounds (TICs) not reported in Table
Concentrations reported in micrograms per kilogram (ug/kg)
J - Estimated value below detection limit
VOCs and Pesticides/PCBs were not detected in sediment samples
SVOCs were not detected in samples other than SDS201 and SDS301
Samples collected in March 1994
Sediment samples not collected during Round 1 field activities

Table 1-7

Summary of Analytical Results

Detected VOCs, SVOCs and Pesticides/PCBs

Remedial Investigation - Round 1 Surface Soils Samples

H.O.D. Landfill

Antioch, Illinois

Compounds	Sample Designation					
	HD-SU01-01	**HD-SU02-01**	**HD-SU03-01**	**HD-SU04-01**	**HD-SU04-91**	**HD-SU05-01**
Detected VOCs						
Detection Limit	62	14	13	64	13	12
Methylene Chloride	570	59	48	1200	210	
Acetone	140	17	8J		15	
Carbon Disulfide		6J				
Benzene	7J					
Toluene	55J	3J			2J	
Ethylbenzene	240	12J				
Xylenes	280	37				
Detected SVOCs						
Detection Limit	410	420	430	420	430	410
1,4-Dichlorobenzene	130J					
Naphthalene	320J	630				
2-Methylnaphthalene	61J	390J				
Acenaphthene	120J	1,000				
Dibenzofuran	59J	620				
Fluorene	68J	500				
Phenanthrene	250J	240J	120J	36J		51J
Anthracene	46J					
Fluoranthene			160J	59J		73J
Pyrene			110J	52J		54J
bis(2-ethylhexyl)-phthalate	160J	320J	280J	3,500	3,600	9,600
Benzo (b) fluoranthene			110J			
Carbazole	130J					
Detected Pesticides/PCBs						
Detection Limit	4.1	4.5	4.3	4.2	4.3	4.1
4,4'-DDD	4.3					

Notes:

Tentatively Identified Compounds (TICs) not reported in Table; TICs results presented in Appendix O-12

Concentrations reported in micrograms per kilogram (ug/kg)

J - Estimated value below detection limit

Surface Soils samples not collected during Round 2 RI sampling activities

Samples collected on May 14, 1993

TABLE 1-8
SUMMARY OF HISTORICAL MONITORING WELL VOC DATA
H.O.D. Landfill RI/FS

SAMPLE ID	Date	Trichloroethene	1,2-Dichloroethene (cis/trans)	Vinyl chloride	4-Methyl-2-pentanone	Acetone	Methylene chloride	Benzene	Toluene
US01D	8/11/87					7J			
US01D	4/19/88					2BJ	0.9BJ		
US01D	5/19/88						10		
US01S	8/11/87					6J			
US01S	4/19/88					1BJ	1BJ		
US01S	5/19/88					28JB			
US03D	5/8/90			12.3					
US03S	8/11/87								
US03S	4/19/88					3BJ	2BJ		
US04D	8/10/87					5BJ	5BJ		
US04D	8/10/87						3J		
US04S	8/10/87		71			21.5			
	4/18/88		69			3			
	5/9/90		41.1						
	7/26/90		41.5						
US06S	8/11/87					7J			
	4/18/88					5BJ	3BJ		
US06D	8/11/87					7			
	4/19/88					4BJ	2BJ		
	5/19/88	0.47					4.2		
	5/9/90	0.5							
	7/26/90	0.7							
US06I	8/12/87	7							
	4/18/88	5				5BJ	2BJ		2J
	5/19/88	5.3	1.2J				1.1J		
	8/18/88	5				5	2		2
US07S	8/11/87					5J		8	
	4/18/88						4BJ	2BJ	
G102	4/18/88					5BJ	2BJ		2J
	5/10/90			2.4					

Notes:

1. This table presents historical data for H.O.D Landfill samples collected from monitoring wells. Only wells and sampling rounds with VOC detects are presented in this table. Acetone and methylene chloride are often lab contaminants. Montgomery Watson did not perform data validation for the sampling rounds and has not assessed data quality.
2. All results are in units of ug/L.
3. The table shows a summary of historical detects and, as such, detection limits vary, and are not reported here.

J - Indicates and estimated value

B - Compound detected in the associated blank as well as the sample.

TABLE 1-9
Summary of Risk Assessment Results
H.O.D. Landfill FS

Exposure Pathway	RME Excess Lifetime Cancer Risk	Contaminants of Concern (a)
Child/Teenage Site Trespasser		
Incidental Surface Soil Ingestion	9.E-08	NA
Dermal Absorption from Surface Soil	1.E-05	Beryllium
Dermal Contact with Surface Water	NE	NA
Incidental Sediment Ingestion	2.E-07	NA
Dermal Absorption from Sediment	1.E-07	NA
Inhalation of Volatiles from Ambient Air	4.E-09	NA
Direct Contact with Carcinogenic PAHs		
Surface Soil	Cancer risk not likely	NA
Sediment	Cancer risk not likely	NA
Total Risk	1.E-05	Beryllium
Nearby Adult Resident		
Ingestion of Groundwater		
Off-Site Surficial Sand	5.E-05	Beryllium
Off-Site Deep Sand and Gravel	8.E-04	Vinyl Chloride
Municipal Wells	9.E-05	Arsenic
Private Wells	NE	NA
Inhalation of Volatiles while Showering		
Off-Site Deep Sand and Gravel	6.E-05	Vinyl Chloride
Municipal Wells	5.E-07	NA
Dermal Absorption While Showering		
Off-Site Surficial Sand	2.E-05	Beryllium
Off-Site Deep Sand and Gravel	3.E-05	Vinyl Chloride
Municipal Wells	2.E-07	NA
Private Wells	NE	NA
Inhalation of Volatiles from Ambient Air	5.E-07	NA
Total Risk by Aquifer/Well Type		
Off-Site Surficial Sand	7.E-05	Beryllium
Off-Site Deep Sand and Gravel	9.E-04	Vinyl Chloride
Municipal Wells	9.E-05	Arsenic
Private Wells	5.E-07	NA

Information taken from "Baseline Risk Assessment for the H.O.D. Landfill Site Antioch, Illinois," The Weinberg Group, Inc./ICF Kaiser, 1997.

Notes:
NA = Not applicable
NE = Not evaluated since chemicals relevant for this health endpoint were not selected
or detected in this data grouping.

(a) Contaminants of Concern are those with RME cancer risks greater than 1.E-06.

Table 2-1: Potential Chemical-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Surface Water	Protect State water for aquatic life, agricultural use, primary and secondary contact use, most industrial use, and to ensure aesthetic quality of aquatic environment.	Water Quality Standards 35 IAC 302.202-302.212
	Pretreatment Standards of State and local POTW	35 IAC 310.201-220, 35 IAC 307.1101-1103
	Effluent Guidelines and Standards	35 IAC 304.102-126
	Prohibition of discharge of oil or hazardous substances into or upon navigable waters	Federal Water Pollution Control Act Section 311(b)(3) 40 CFR 110.6, 117.21
	Comply with all applicable Federal and State water quality criteria.	CWA Section 304(a) and information published in the Federal Register pursuant to this section; 35 IAC 302.612-669
Groundwater	Meet State Groundwater Quality Standards using a Groundwater Management Zone, if appropriate	35 IAC 620.410 unless modified in accordance with the substantive requirements in 35 IAC 620.250 to 350
Air	Air Quality Standards	35 IAC 243.120-126

Table 2-2: Potential Location-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Floodplains	Action to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values (in relation to implementation of the RA).	Executive Order 11988, Floodplain Management, 40 CFR 6, Appendix A, Section 6(a)(5)
	Facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood	35 IAC 724.118(b)
	Governs construction and filling in the regulatory floodway of rivers, lakes, and streams of Cook, DuPage, Kane, Lake, McHenry, and Will Counties, excluding the City of Chicago	92 IAC Part 708
	Minimum requirements for stormwater management aspects of new development in Lake County	Lake County Stormwater Management Commission Watershed Development Ordinance
Wetlands	Action to minimize the destruction, loss, or degradation of wetlands	Executive Order 11990, Protection of Wetlands, 40 CFR 6, Appendix A, Section 6(a)(5)
	Action to minimize adverse effects of dredged or fill materials	CWA, 40 CFR 230.70-230.77
	Permits for Dredged or Fill Material	CWA Section 404

Table 2-2: Potential Location-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Stream	Requires Federal agencies involved in actions that will result in the control or structural modification of any stream or body of water for any purpose, to take action to protect the fish and wildlife resources which may be affected by the action	Fish and Wildlife Coordination Act, 40 CFR 6.302(g)
	Action to minimize adverse effects of dredged or fill materials	CWA, 40 CFR 230.70-230.77
	Permits for Dredged or Fill Material	CWA Section 404

Table 2-3: Potential Action-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Capping	Final cover system: A compacted layer of not less than two feet of suitable material shall be placed over the entire surface of each portion of the final lift not later than 60 days following the placement of refuse in the final lift.	35 IAC 807.305(c)
	Cover stabilization: Residual settlement erosion control work; residual settlement and erosion control work; mowing	35 IAC 807.622(d)(3)
Post Closure Care	An operator of a waste management site shall close the site is a manner which minimizes the need for further maintenance; and controls, minimizes or eliminates post-closure release to waste, waste constituents, leachate, contaminated rainfall, or waste decomposition products to the groundwater or surface waters or to the atmosphere to the extent necessary to prevent threats to human health or the environment.	35 IAC 807.502
	Groundwater Monitoring Program: Number of monitoring points, parameters to be monitored, frequency of sampling, cost per parameter per sampling	35 IAC 807.622(d)(2)
	Landfill Gas Monitoring Program: Control, minimize or eliminate post-closure release to waste, waste constituents, leachate, contaminated rainfall, or waste decomposition products to the groundwater or surface waters or to the atmosphere to the extent necessary to prevent threats to human health or the environment	35 IAC 807.502(b)

Table 2-3: Potential Action-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Leachate Treatment Storage and Disposal	Leachate Treatment and Disposal system: Control, minimize or eliminate post-closure release to waste, waste constituents, leachate, contaminated rainfall, or waste decomposition products to the groundwater or surface waters or to the atmosphere to the extent necessary to prevent threats to human health or the environment	35 IAC 807.502(b)
Landfill Gas Management	Visible and particulate matter emission standards and limitations	35 IAC 212.123 (visible) and 212.321 (particulate)
	Sulfur air emissions standards and limitations	35 IAC 214.162
	Organic material emissions standards and limitations	35 IAC 215.143
	Carbon monoxide emissions standards and limitations	35 IAC 216.121, 216.141
	Nitrogen oxide emissions standards	35 IAC 217.121
	Volatile Organic Material emission standards	35 IAC 218.143
	Verify that there is no "excessive release" of hydrogen sulfide emissions during landfill gas management.	35 IAC 211.2090, 35 IAC 214.101
	Verify that emissions of hazardous pollutants do not exceed levels expected from sources in compliance with hazardous air pollution regulations.	415 ILCS 5/9.1(b), CAA Section 112, 40 CFR 61.12-14
Gas Collection	Estimate emission rates for each pollutant expected.	35 IAC 291.202
	Develop a modeled impact analysis of source emissions.	35 IAC 291.206
	Use Reasonably Available Control Technology (RACT).	35 IAC 211.5370, 35 IAC Part 215, Appendix E

Table 2-3: Potential Action-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Landfill Gas Processing and Disposal	Estimate emission rates for each pollutant expected.	35 IAC 291.202
	Develop a modeled impact analysis of source emissions.	35 IAC 291.206
	Use Reasonably Available Control Technology (RACT).	35 IAC 211.5370, 35 IAC Part 215, Appendix E
Direct Discharge of Treatment System Effluent	The discharge must be consistent with the relevant Water Quality Management Plan approved by EPA under Section 208(b) of the CWA, and developed by Illinois EPA.	CWA Section 208(b)
	Use of Best Available Technology (BAT) that is economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis.	CWA Section 306, 40 CFR 122.44(a), and 35 IAC 301.400
	Discharge limitations must be established for all toxic pollutants that are or may be discharged at levels greater than those that can be achieved by technology-based standards.	CWA Section 307(a), 40 CFR 122.44(e), and 35 IAC 309.152
	The discharge must be monitored to assure compliance. The discharger will monitor: - The mass of each pollutant discharged, - The volume of effluent discharged, and - The frequency of discharge and other measurements as appropriate.	40 CFR 122.44(I) and 35 IAC 309.146(a)

Table 2-3: Potential Action-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
	Approved test methods for waste constituents to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided.	CWA, 40 CFR 122.21
	Duty to mitigate any adverse effects of any discharge.	40 CFR 122.41(d)
	Proper operation and maintenance of treatment and control systems.	40 CFR 122.41(e)
	Develop and implement a Best Management Practices (BMP) program to prevent the release of toxic constituents to surface waters. The BMP program must: - Establish specific procedures for the control of toxic and hazardous pollution spills, - Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure, and - Assure proper management of solid and hazardous waste in accordance with regulations promulgated under RCRA.	CWA Section 304(e), 40 CFR 125.104
	Sample preservation procedures, container materials, and maximum allowable holding times are prescribed.	40 CFR 136.3
Discharge to Surface Water	Effluent standards which establish maximum contaminant concentrations that may be discharged to the waters of the State.	35 IAC 304.101-304.126
Discharge to Sewers	Sewer discharge criteria	35 IAC 307.1101-1103

Table 2-3: Potential Action-Specific ARARs
H.O.D. Landfill Superfund Site - Antioch, Illinois

MEDIA	REQUIREMENT	CITATION
Discharge to POTW	Prevent introduction of pollutants into POTW which will interfere with POTW operation.	35 IAC 310.201(a)(c) and 310.202, and local POTW regulations

Table 3-1
Leachate Treatment Processes
H.O.D. Landfill
Antioch, Illinois

Compounds to Treat	Treatment Processes (variations)
VOCs	Air stripping - tray - tower Oxidation - ozone - peroxide - UV Granular activated carbon Ultrafiltration Reverse osmosis Electrodialysis Aerobic biological treatment Anaerobic biological treatment Fixed film biological treatment Suspended growth biological treatment
SVOCs	Same as above, less air stripping
Ammonia	Air stripping Biological treatment (requires aerobic and anoxic in series, e.g., SBR) Reverse osmosis
Metals	Chemical precipitation - lime - caustic - sulfide Ion exchange - cationic - anionic Oxidation and filtration/clarification Ultrafiltration Reverse osmosis Electrodialysis

Table 3.2
Summary of Remedial Action Alternatives

Action Components	Description
No Further Action	
NFA	Under existing IEPA permit, cap maintenance, operation and maintenance ofthe existing LFG and manual leachate collection systems, and groundwater monitoring activities would be performed.
Capping	
C1	Restoration of Cap: The cap would be restored to the original grades established and approved by the IEPA in the Site Closure Plan. Clay would be imported to fill low areas and repair leachate seeps.
C2	Augmentation of Cap: The existing cover soils would be reworked to form a more uniform 35 IAC 807 compliant cap consisting of two feet of compacted clay with additional cover soil.
C3	Reconfiguration/Supplementation of Cap: Existing cover soils would be reworked and supplemented (if necessary) to form a 35 IAC 811 compliant cap.
LFG Collection and Treatment	
G1	No Further Action: Continue to passively vent LFG with existing stick flares.
G2	Supplement Existing System: Existing passive flares in new landfill would be repaired and operated. LFG collection/treatment supplemented through addition of an active system in old landfill. Pilot/Predesign investigation.
G3	Activation of LFG System: Stick flares converted to wells, additional wells in old portion of Site would be installed, and LFG conveyed to centralized blower/flare station. Pilot/Predesign investigation.
Leachate Collection	
LC1	No Further Action: Continue to utilize existing system.
LC2	Toe-of-Slope Leachate Collection: Toe-of-slope collection piping extended along toe of both old and new section of landfill and existing extraction points used. Automated system.
LC3	Upgrade/Supplement Leachate System: Toe-of-slope piping extended in new section only. Dual extraction system with blower/flare station constructed in old section of landfill. Pilot/Predesign investigation.
LC4	Active Leachate Extraction: Existing gas and leachate wells in both sections converted to dual extraction wells. Pilot/Predesign investigation.
Leachate Treatment/Disposal	
LT1	No Further Action: Continue to directly discharge to licensed POTW.
LT2	Pretreat/Discharge Leachate: Physical/chemical pretreatment of leachate followed by discharge to licensed POTW.
LT3	Pretreat/Surface Discharge Leachate: Full treatment of leachate to NPDES standards followed by remote surface discharge to surface water source (not Sequoit Creek).
Contingent Groundwater Remediation	
RA1	No Further Action: Implement groundwater monitoring.
RA2	Implement Well Head Treatment.

TABLE 3-3
Cost Estimate Summary

	Capital	Annual O&M	P.W. O&M	Total P.W.
No Further Action				
NFA	$0	$218,000	$3,351,096	$3,351,096
Capping				
C1	$1,475,000	$88,000	$1,360,000	$2,835,000
C2	$5,252,000	$88,000	$1,360,000	$6,612,000
C3 (Supplemental Clay)	$7,498,000	$88,000	$1,360,000	$8,858,000
C3 (Replacement Clay)	$9,886,000	$88,000	$1,360,000	$11,246,000
Gas Extraction / Treatment				
G1 - No Action	$227,500	$50,000	$768,600	$996,100
G2	$714,155	$35,000	$538,020	$1,252,175
G3	$910,000	$50,000	$768,600	$1,678,600
Leachate Extraction				
LC1 - No Action	$0	$5,000	$76,860	$76,860
LC2	$227,800	$60,000	$922,320	$1,150,120
LC3	$345,550	$72,000	$1,107,000	$1,425,550
LC4	$403,500	$60,000	$922,320	$1,325,800
Leachate Treatment				
LT1 - No Action	$0	$75,000	$1,152,900	$1,152,900
LT2	$489,000	$588,000	$9,038,736	$9,527,736
LT3 (Low Range)	$1,363,000	$550,000	$8,454,600	$9,817,600
LT3 (High Range)	$1,912,000	$635,000	$9,761,220	$11,673,220
Contingent Groundwater Remediation				
RA1	$95,600	$0	$1,374,000	$1,469,600
RA2	$534,000	$0	$0	$534,000

Note: Present Worth calculated at i = 5%, n = 30 years, Factor = 15.37.
Cost for abandonment of well VW4 ($652,800) was not included in RA2 alternative.

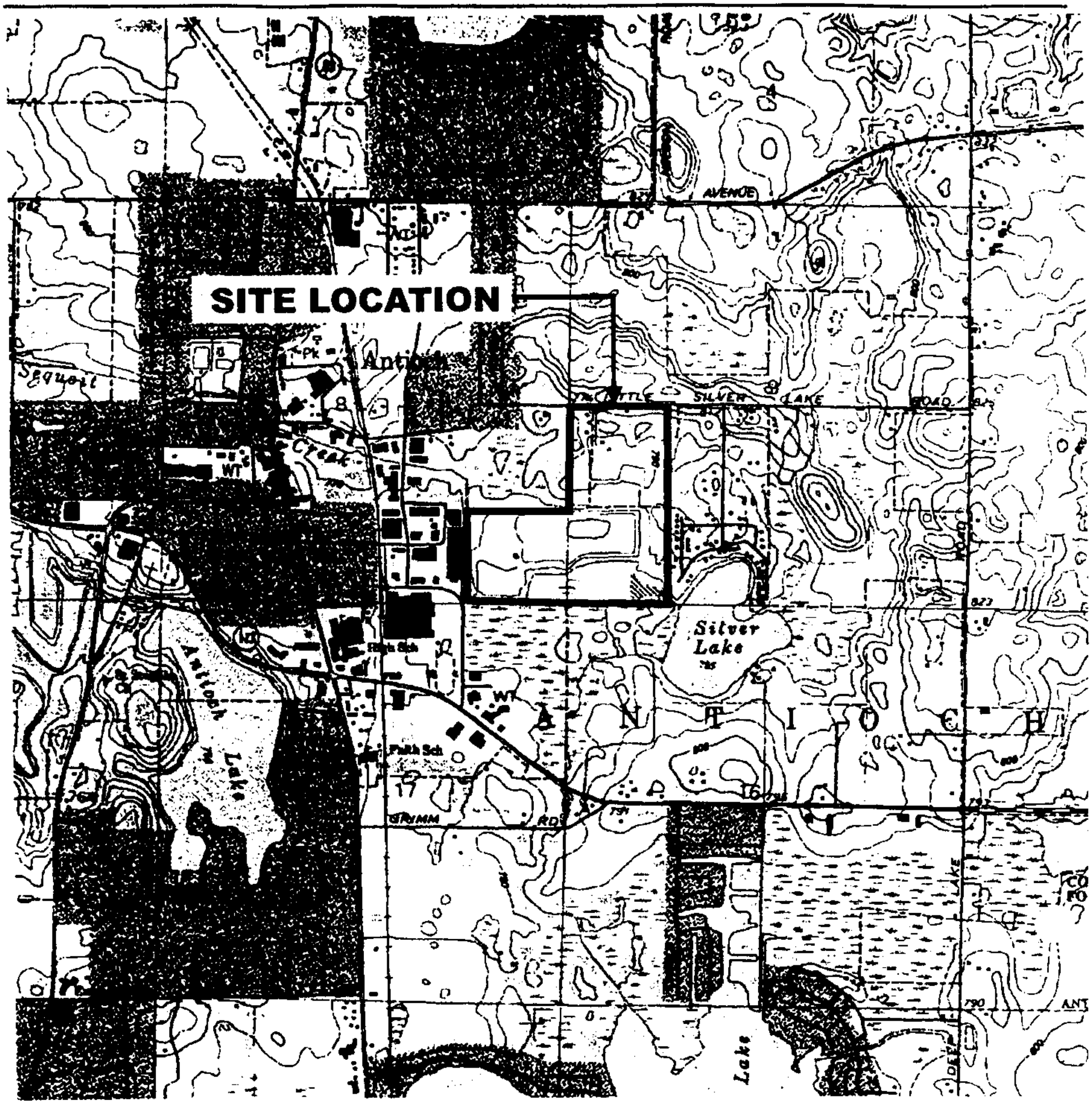
TABLE 4-1
Summary of Vinyl Chloride Detected In
Village Well No. 4
H.O.D. Landfill FS

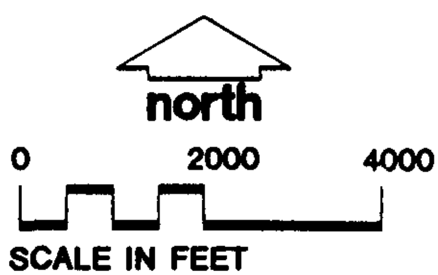
Date	Concentration of *Vinyl chloride*
1-Feb-84	ND-6.7
22-Feb-84	--
16-Apr-84	--
9-Mar-89	3.6
23-Mar-89	0.4-1.8
24-Mar-89	0.8
22-Aug-89	ND
23-Aug-89	0.2
24-Aug-89	ND-0.2
28-Aug-89	ND-0.2
13-Sep-89	ND-0.2
14-Sep-89	ND
27-Sep-89	ND
26-Oct-89	ND
9-Nov-89	ND
13-Dec-89	ND
16-May-90	ND
7-Jan-92	ND
7-Apr-92	ND
4-Jun-92	ND
6-Jul-92	ND
3-Aug-92	ND
4-Aug-92	ND
16-Sep-92	ND
21-Oct-92	ND
3-Nov-92	ND
11-Jan-93	ND
8-Feb-93	ND
1-Mar-93	ND
6-Apr-93	ND
4-May-93	ND
31-Mar-94	ND

Notes:

1. This table presents all reported detects of volatile organic compounds in water samples collected from Village Well No. 4 finished water collected following treatment (i.e., chlorination and treatment with polyphosphates).
2. *Sampling was conducted by the Village of Antioch.*
3. Results are in ug/L.
4. - = Not analyzed
5. ND = not detected
6. Detection limits for vinyl chloride were variable, refer to the Baseline RA

FIGURES



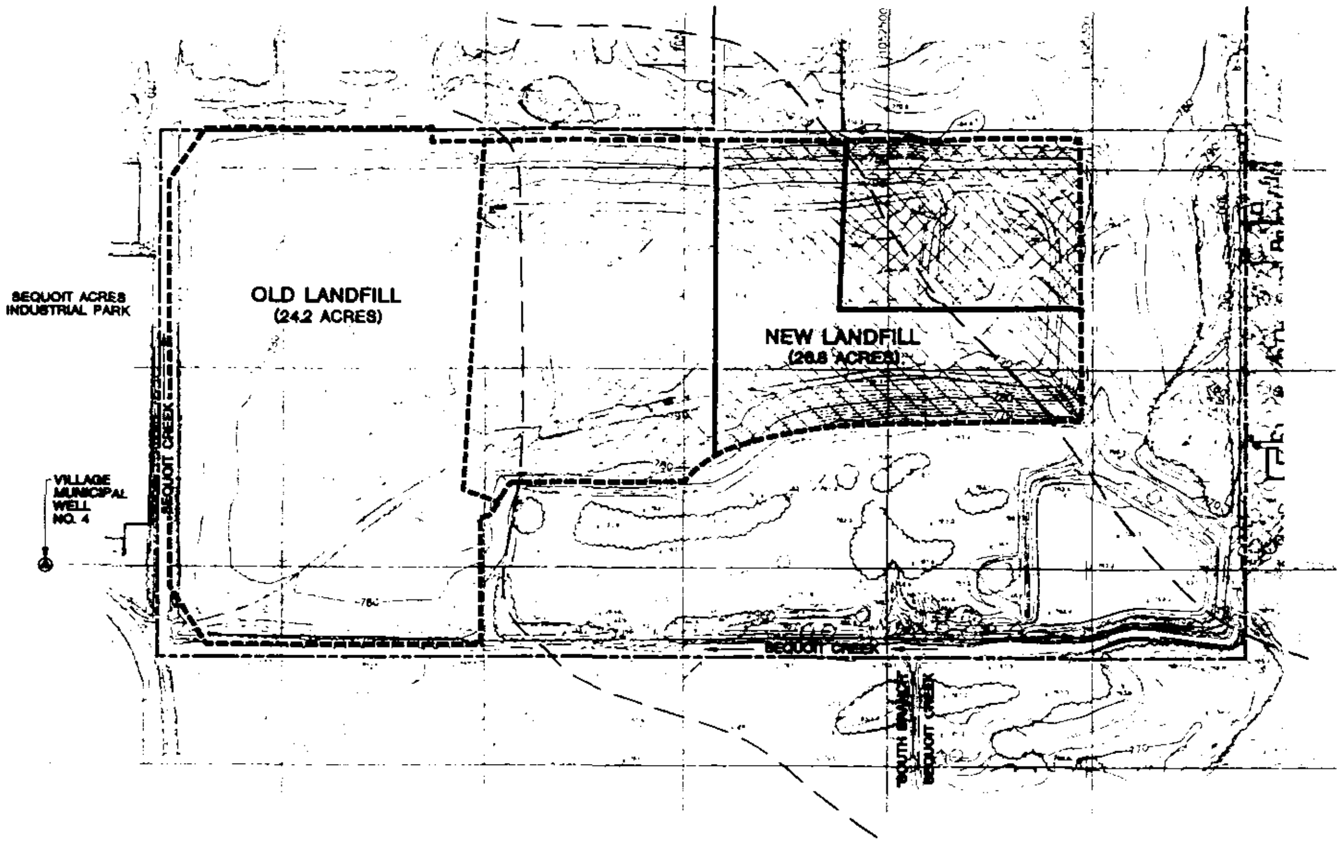


NOTE
BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.

FIGURE 1

Developed By SJC	Drawn By CCM	SITE LOCATION MAP	Drawing Number 1252035 03090210 A1
Approved By	Date	FEASIBILITY STUDY H.O.D. LANDFILL WASTE MANAGEMENT OF ILLINOIS, INC. ANTIOCH, ILLINOIS	MONTGOMERY WATSON
Reference			
Revisions			

QUALITY CONTROL
Graphic Standards CCM 4-8-97
Lead Professional
Technical Review
Project Manager
Management Review
Other



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- ACCESS ROAD
- BUILDING
- SPOT ELEVATION
- FENCE LINE
- APPROXIMATE LIMIT OF SEQUOIT CREEK MARCH PRIOR TO CHANNELIZATION
- APPROXIMATE LOCATION OF AREA OPERATED USING "TRENCH FILL" METHOD
- APPROXIMATE LOCATION OF AREA OPERATED USING "AREA FILL" METHOD
- APPROXIMATE LOCATION OF PORTION OPERATED AS "DEEP TRENCH" AREA

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. TOPOGRAPHY IS BASED IN U.S.G.S. DATUM.
3. GRID BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM.

north

0 300 600

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FIGURE 2

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	Lead Professional	Project Manager	Other

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SITE FEATURES MAP

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
1252035
03090210 B1

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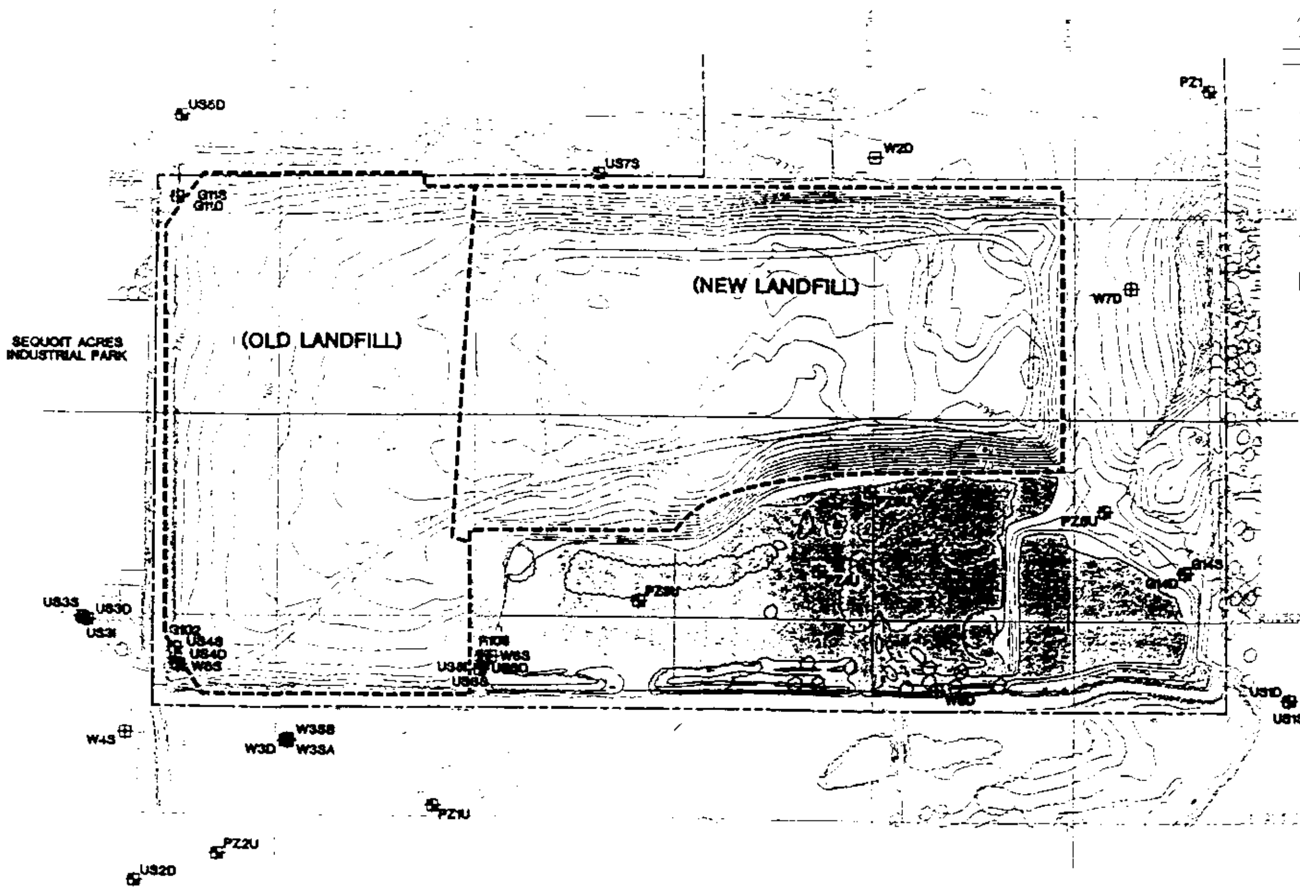

LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- R103 TSC MONITORING WELL LOCATION AND NUMBER
- PZ1U PELA PIEZOMETER LOCATION AND NUMBER
- US4S USEPA MONITORING WELL LOCATION AND NUMBER
- G11S TSC MONITORING WELL LOCATION AND NUMBER
- W7D WARZYN MONITORING WELL LOCATION AND NUMBER
- APPROXIMATE AREA OF SEASONAL WETLAND (NOTE 4.)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.
4. WETLAND AREA SHOWN HERE IS CONSISTENT WITH INFORMATION PRESENTED IN PELA H.O.D. LANDFILL WETLANDS ASSESSMENT, JULY 1993 AND JJR, INC. WETLAND MITIGATION BANKING STUDY JULY 1997.

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0 300 600

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FIGURE 3

MONITORING WELL AND PIEZOMETER LOCATION MAP

FEASIBITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

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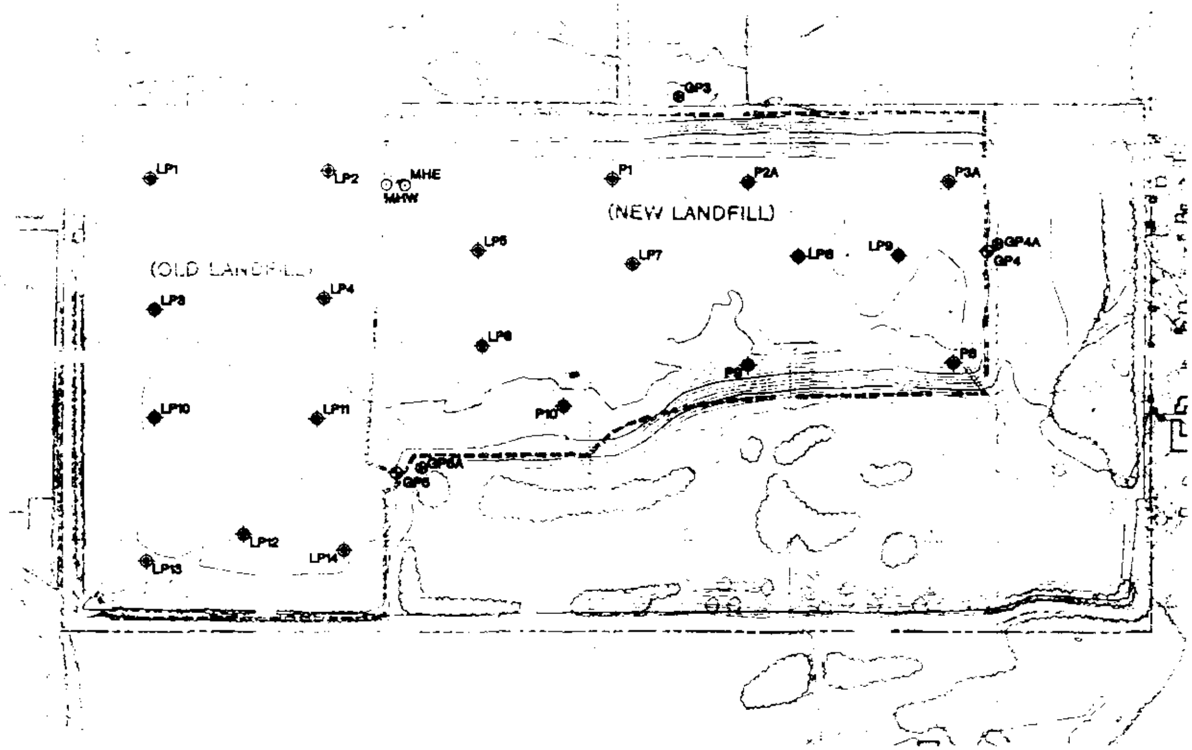

LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- LP6 WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
- GP5A WARZYN GAS PROBE LOCATION AND NUMBER
- MHW/MHE LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- P2A LEACHATE EXTRACTION WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993

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0 300 600

SCALE IN FEET

FIGURE 4

LEACHATE PIEZOMETER AND GAS PROBE LOCATION MAP

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC
ANTIOCH, ILLINOIS

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Drawing Number
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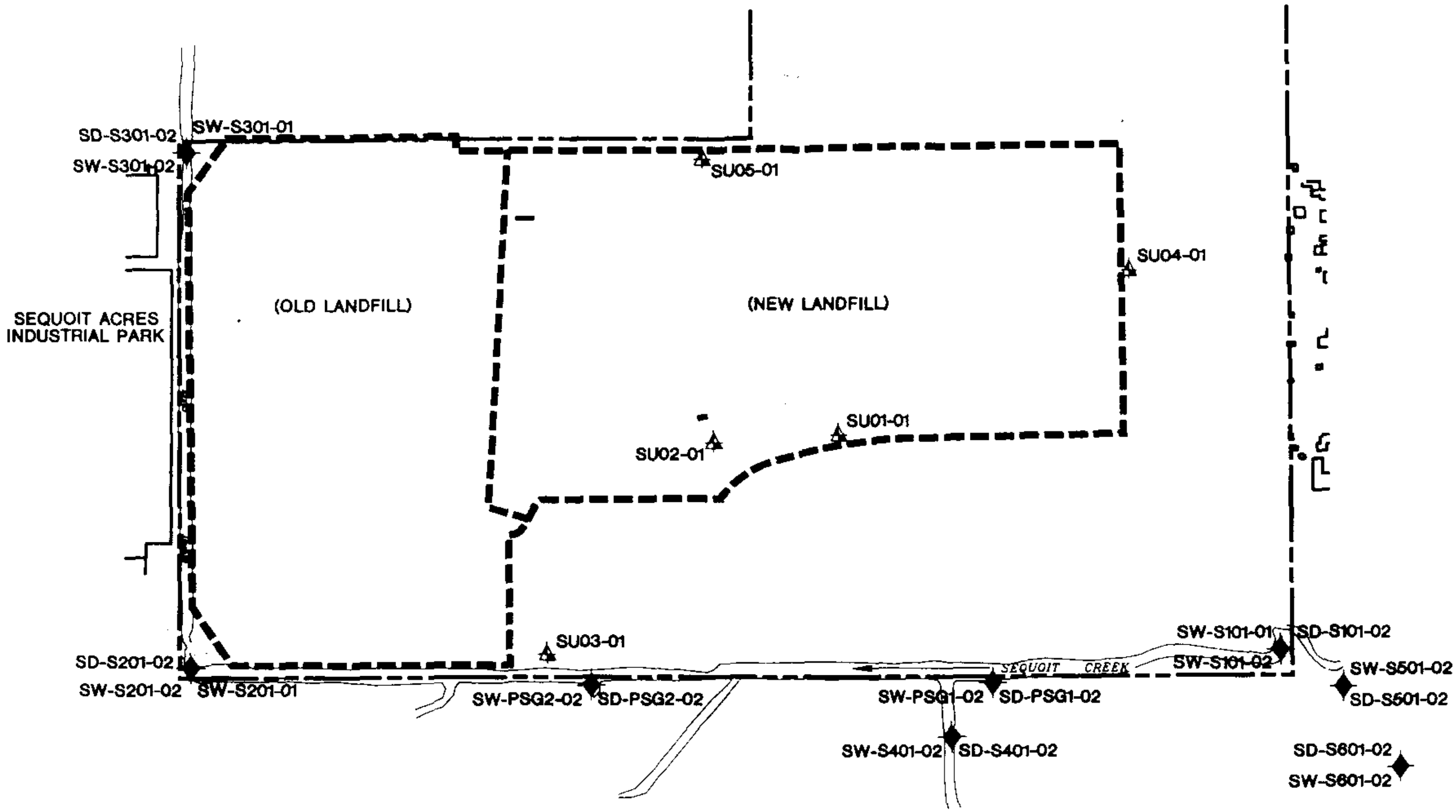
	Lead Professional	Project Manager	Other



LEGEND

APPROXIMATE PROPERTY LINE

APPROXIMATE LIMITS OF LANDFILLED AREA

ACCESS ROAD

BUILDING

S202 SURFACE WATER/SEDIMENT SAMPLING LOCATION AND NUMBER

SU01-01 ROUND I WARZYN SURFACE SOIL SAMPLING LOCATION AND NUMBER

NOTES

1. REFER TO DRAWING 10010201-F2 FOR ADDITIONAL NOTES AND LEGEND.
2. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY DURING JUNE AND JULY 1993.
4. ROUND I SAMPLES (i.e., SD-S101-01) COLLECTED IN MAY 1993. ROUND II SAMPLES (i.e., SD-S101-02) COLLECTED IN MARCH 1994.

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0 250 500

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FIGURE 5

SURFACE WATER/SEDIMENT AND SURFACE SOIL SAMPLING LOCATION MAP (ROUND I AND II)

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

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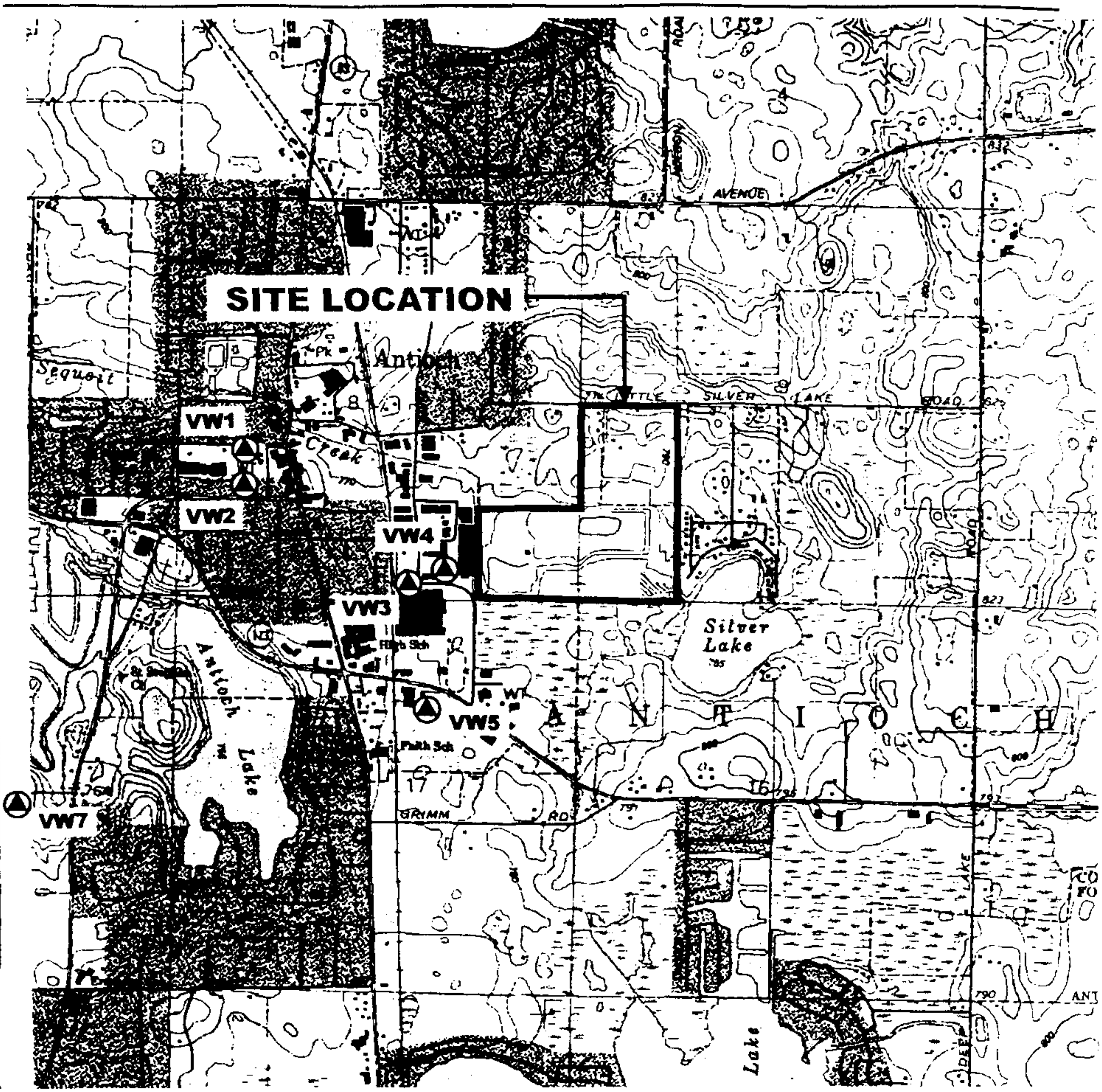

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LEGEND

VW1 — VILLAGE WATER SUPPLY WELL LOCATION AND NUMBER

NOTE

BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.

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0 2000 4000

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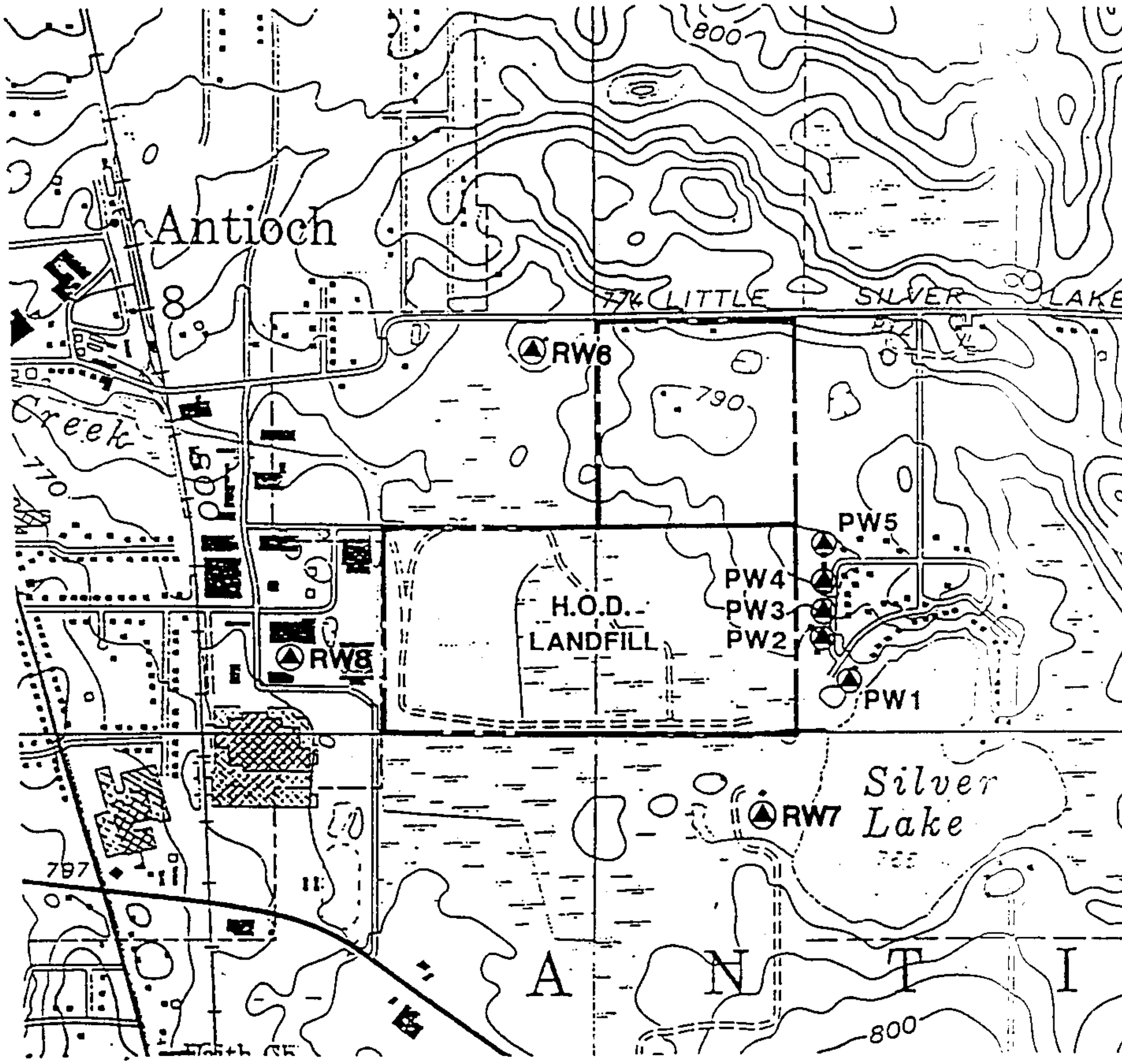
FIGURE 6

Developed By SJC	Drawn By CCM	**VILLAGE WATER SUPPLY WELL LOCATION MAP**	Drawing Number 1252035 03090210 **A2**
Approved By	Date	FEASIBILITY STUDY H.O.D. LANDFILL WASTE MANAGEMENT OF ILLINOIS, INC. ANTIOCH, ILLINOIS	**MONTGOMERY WATSON**
Reference			
Revisions			



LEGEND

PW1 PRIVATE WELL SAMPLING LOCATION AND NUMBER

RW6 RESIDENTIAL WELL SAMPLED DURING AUGUST 1987 PHASE OF USEPA ESI.

NOTE

1. BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS-WISCONSIN 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.
2. PW1 THROUGH PW5 CORRESPOND TO RW1 THROUGH RW5 LOCATIONS SAMPLED DURING THE AUGUST 1987 PHASE OF USEPA ESI.

north

0 1000 2000

SCALE IN FEET

FIGURE 7

Developed By SJC	Drawn By CCM	**PRIVATE WATER SUPPLY WELL SAMPLING LOCATIONS**	Drawing Number 1252035 03090210 A3
Approved By	Date	FEASIBILITY STUDY H.O.D. LANDFILL WASTE MANAGEMENT OF ILLINOIS, INC. ANTIOCH, ILLINOIS	**MONTGOMERY WATSON**
Reference			
Revisions			

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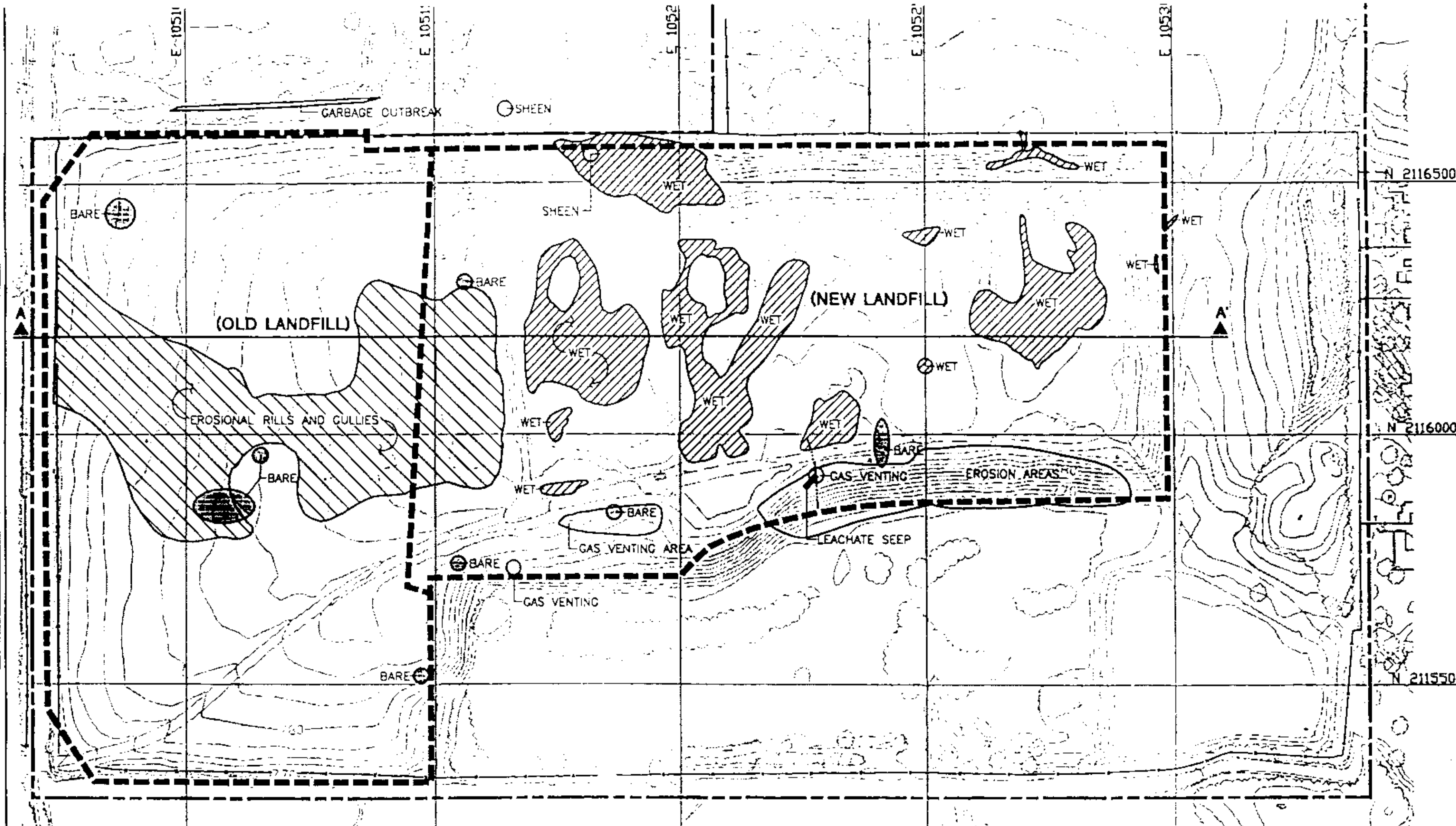

LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- ACCESS ROAD
- BUILDING
- FENCE LINE
- DOCUMENTED AREAS
- A A' CROSS SECTION LOCATION

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LANDFILL COVER SURVEY DOCUMENTED BY WARZYN INC. ON MARCH 23 AND 24, 1994

north

0 200 400

SCALE IN FEET

FIGURE 8

EXISTING CONDITIONS - LANDFILL COVER

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By LAB
Drawn By LCL
Approved By
Date
Reference 2386.0096-B4
Revisions

Drawing Number
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03090210 B

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Lead Professional | Project Manager | Other

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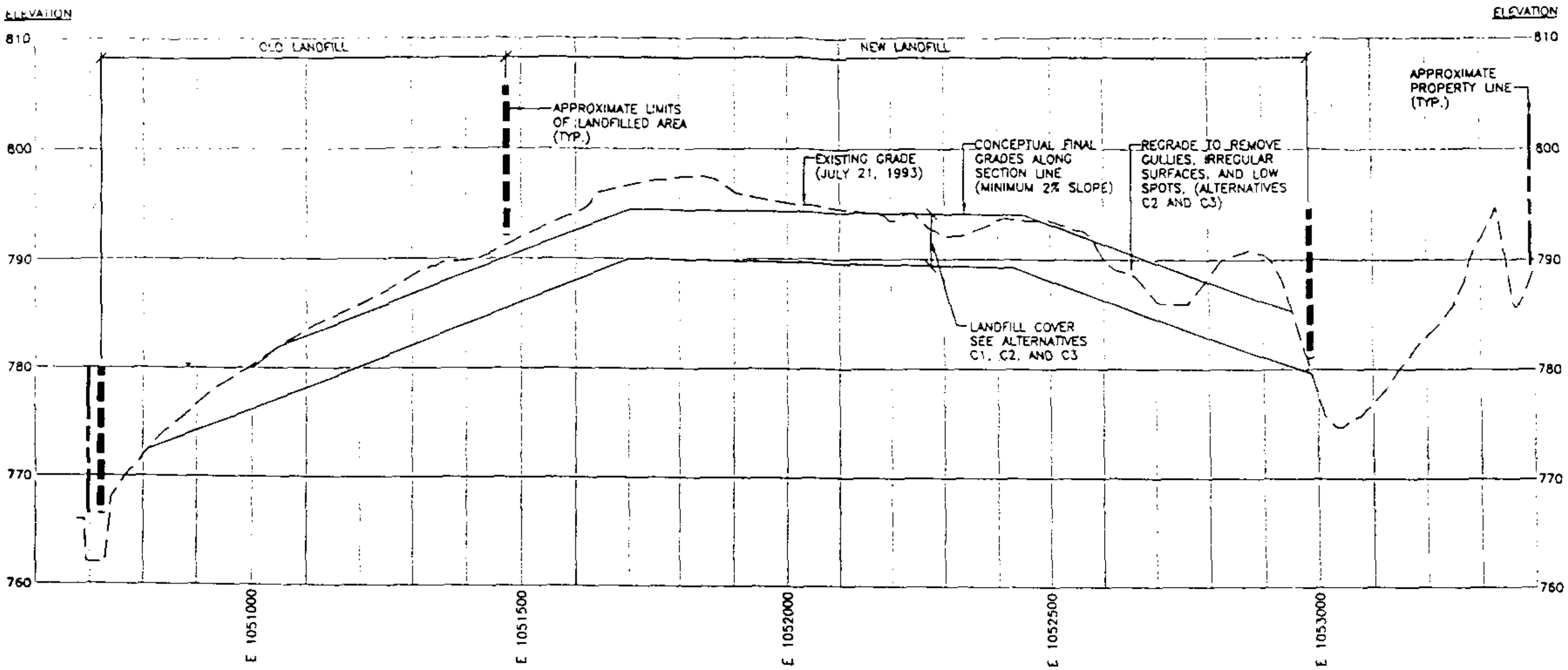
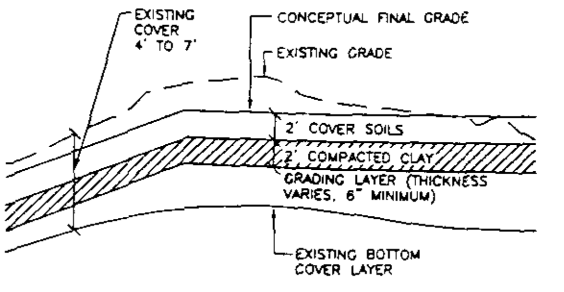
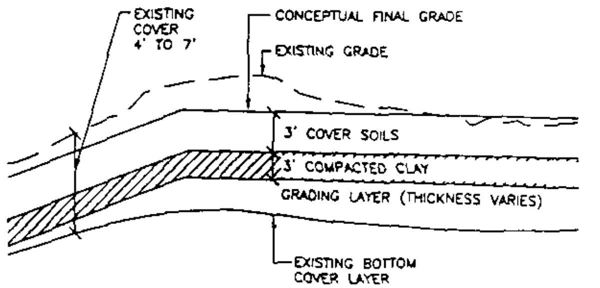




1/2 **CAP ALTERNATIVE C2-REWORK EXISTING**
NOT TO SCALE



2/2 **CAP ALTERNATIVE C3-SUPPLEMENTING CLAY**
NOT TO SCALE

NOTE
REFER TO DRAWING B1 FOR CROSS SECTION LOCATION.

CROSS SECTION SCALE

SCALE IN FEET
VERTICAL EXAGGERATION: TWENTY TIMES

FIGURE 9

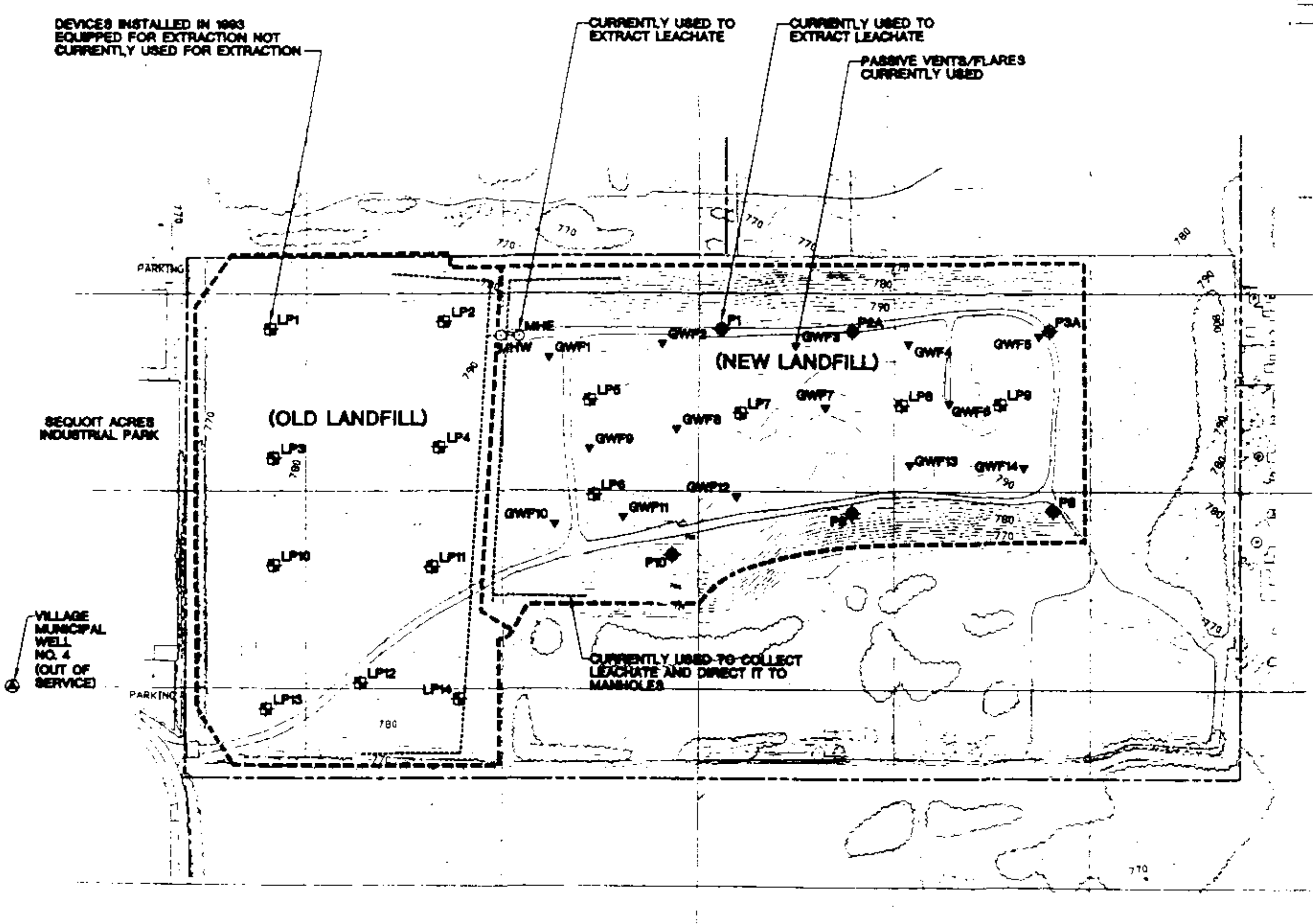
CROSS SECTION A-A' and CONCEPTUAL DETAILS OF CAP ALTERNATIVES C2 & C3

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By LAB
Drawn By DLF
Drawing Number 1252035 031801 B2

MONTGOMERY WATSON

QUALITY CONTROL	Graphic Standards DLF 3-19-97	Technical Review LAB 3-19-97	Management Review
	Lead Professional	Project Manager	Other



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 — TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- MHW/MHE — LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- GWF1 — GAS FLARE LOCATION AND NUMBER
- P2A — LEACHATE EXTRACTION WELL LOCATION AND NUMBER
- LP8 — WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
- LEACHATE COLLECTION PIPE (LOCATION APPROXIMATE)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993

north

0 300 600

SCALE IN FEET

FIGURE 10

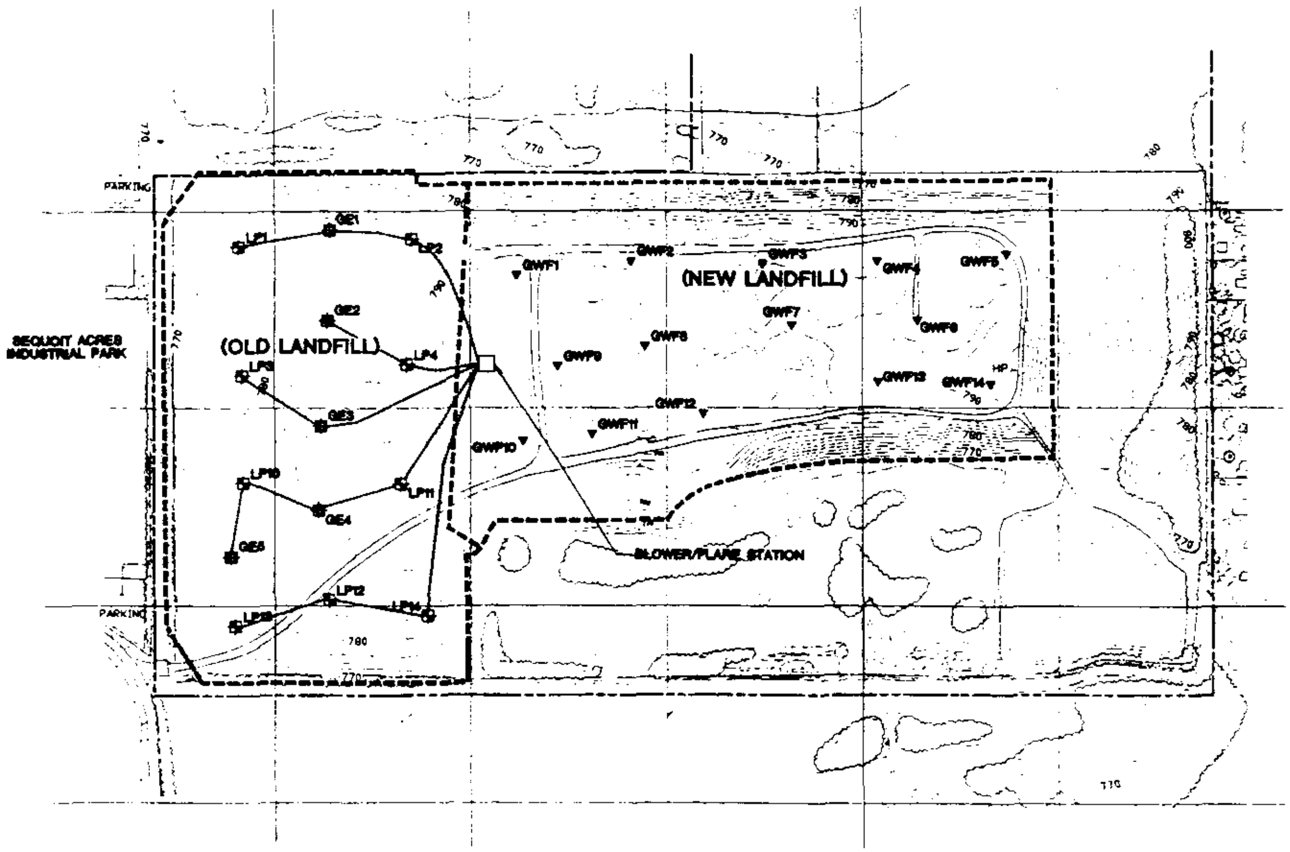
EXISTING GAS AND LEACHATE EXTRACTION DEVICES

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By LAB
Drawn By LCL
Approved By
Date
Reference J/1252/035/03090210/WNDWGS/B10.dwg
Revisions

Drawing Number 1252035 03090210 B10

MONTGOMERY WATSON



LEGEND (EXISTING)

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- GWF1 GAS FLARE LOCATION AND NUMBER
- LP8 LEACHATE PIEZOMETER LOCATION AND NUMBER

LEGEND (PROPOSED)

- GE1 GAS EXTRACTION WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

ALTERNATIVE G2 PROPOSES

1. USE OF EXISTING EXTRACTION DEVICES GWF1-GWF14 FOR LFG COLLECTION IN "NEW LANDFILL."
2. USE OF EXISTING LEACHATE PIEZOMETERS LP1-LP4 AND LP10-LP14 FOR LFG EXTRACTION IN "OLD LANDFILL."
3. CONSTRUCTION OF NEW LFG WELLS GE1-GE5
4. CONSTRUCTION OF HEADER PIPING SYSTEM AND BLOWER/FLARE STATION IN "OLD LANDFILL."

north

0 300 600

SCALE IN FEET

FIGURE 11

ALTERNATIVE G2-UPGRADE/SUPPLEMENTATION OF LFG SYSTEM

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By	TST	Drawn By	DKP
Approved By	TAB	Date	2/5/98
Reference	J/1252/035/03090210/WINDOWS/B11		
Revisions			

Drawing Number 1252035 03090210 B11

MONTGOMERY WATSON

QUALITY CONTROL	Graphic Standards DLF 3-18-97	Technical Review LAB 3-19-97	Management Review
	Lead Professional DRF 3-17-97	Project Manager	Other

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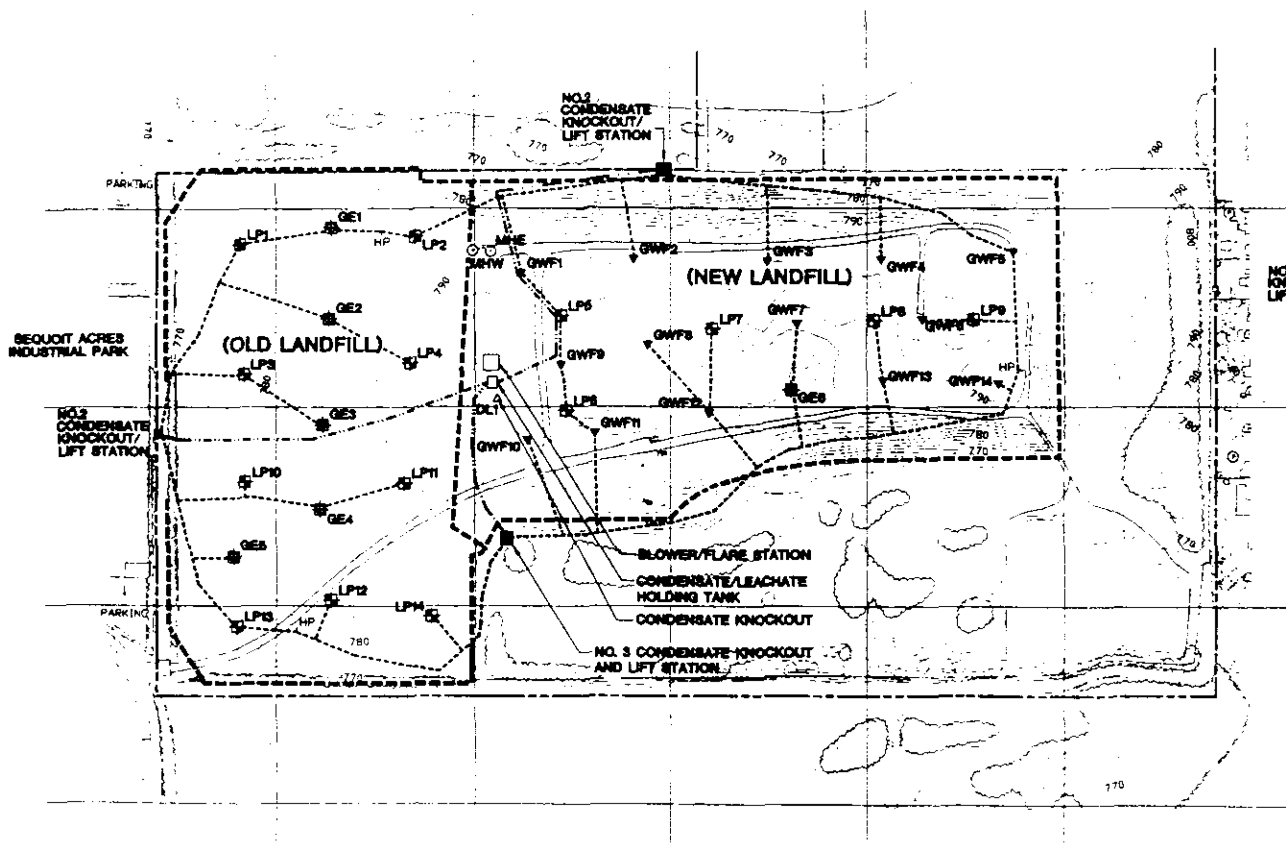

NOTE
THIS PIPING CONFIGURATION IS THE SAME FOR ALTERNATIVES G3 AND LC4.

LEGEND (EXISTING)

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- MHW/MHE LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- GWF1 GAS FLARE LOCATION AND NUMBER
- LP6 LEACHATE PIEZOMETER LOCATION AND NUMBER

LEGEND (PROPOSED)

- GE1 GAS EXTRACTION WELL LOCATION AND NUMBER
- DL1 DRIPLEG LOCATION AND NUMBER
- GAS HEADER PIPE (AND LEACHATE HEADER, IF DUAL SYSTEM)
- CONDENSATE/LEACHATE CONVEYANCE PIPE
- CONDENSATE KNOCKOUT/LIFT STATION LOCATION AND NUMBER
- HP PIPING HIGH-POINT LOCATION

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

ALTERNATIVE G3 PROPOSES

1. USE OF EXISTING EXTRACTION DEVICES GWF1-GWF14, LP1-LP14.
2. CONSTRUCTION OF NEW WELLS GE1-GE6.
3. CONSTRUCTION OF HEADER PIPING, CONDENSATE DRIPLEGS, BLOWER AND FLARE.

ALTERNATIVE LC4 PROPOSES

IN ADDITION TO ITEMS 1-3 OF ALTERNATIVE G3, LEACHATE HEADER PIPING WILL BE ADDED TO PIPE TRENCHES.

north

0 300 600

SCALE IN FEET

FIGURE 12

ALTERNATIVE G3-ACTIVATION OF LFG SYSTEM
ALTERNATIVE LC4-ACTIVE LEACHATE EXTRACTION

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By TST | Drawn By DKP
Approved By TAB | Date 2/5/98
Reference J:/1252/035/03090210/MRDWGS/B12.dwg
Revisions

Drawing Number 1252035 03090210 B12

MONTGOMERY WATSON

QUALITY CONTROL | Graphic Standards DLF 3-18-97 | Lead Professional DRF 3-17-97 | Technical Review LAB 3-19-97 | Project Manager | Management Review | Other

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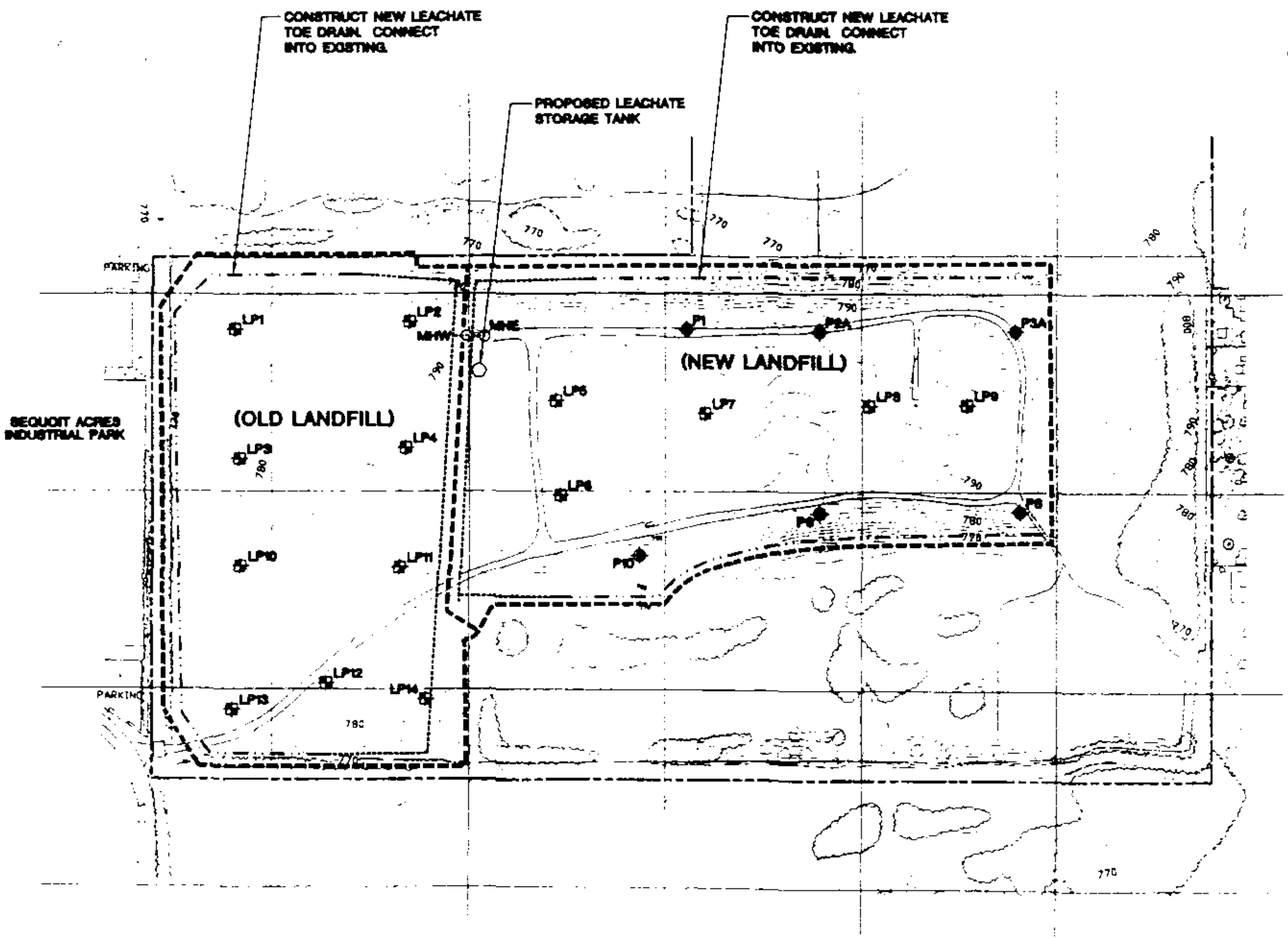
This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

QUALITY CONTROL	Graphic Standards OLF 3-19-97	Technical Review LAB 3-19-97	Management Review
	Lead Professional	Project Manager	Other



LEGEND (EXISTING)

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- MHW/MHE LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- P2A LEACHATE EXTRACTION WELL LOCATION AND NUMBER
- LP6 LEACHATE PIEZOMETER LOCATION AND NUMBER
- EXISTING LEACHATE COLLECTION TOE DRAIN (LOCATION APPROXIMATE)

LEGEND (PROPOSED)

- PROPOSED LEACHATE TOE DRAIN EXTENSION
- PROPOSED LEACHATE STORAGE TANK

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

ALTERNATIVE LC2 PROPOSES

1. CONSTRUCTION OF NEW LEACHATE TOE DRAIN EXTENSIONS.
2. USE OF THE CURRENTLY-USED EXTRACTION DEVICES (MHE, MHW, P1, P2A, P3A, P8, P9, P10)
3. USE OF EXISTING WELLS (LP1-LP14) FOR LEACHATE EXTRACTION AS NECESSARY.

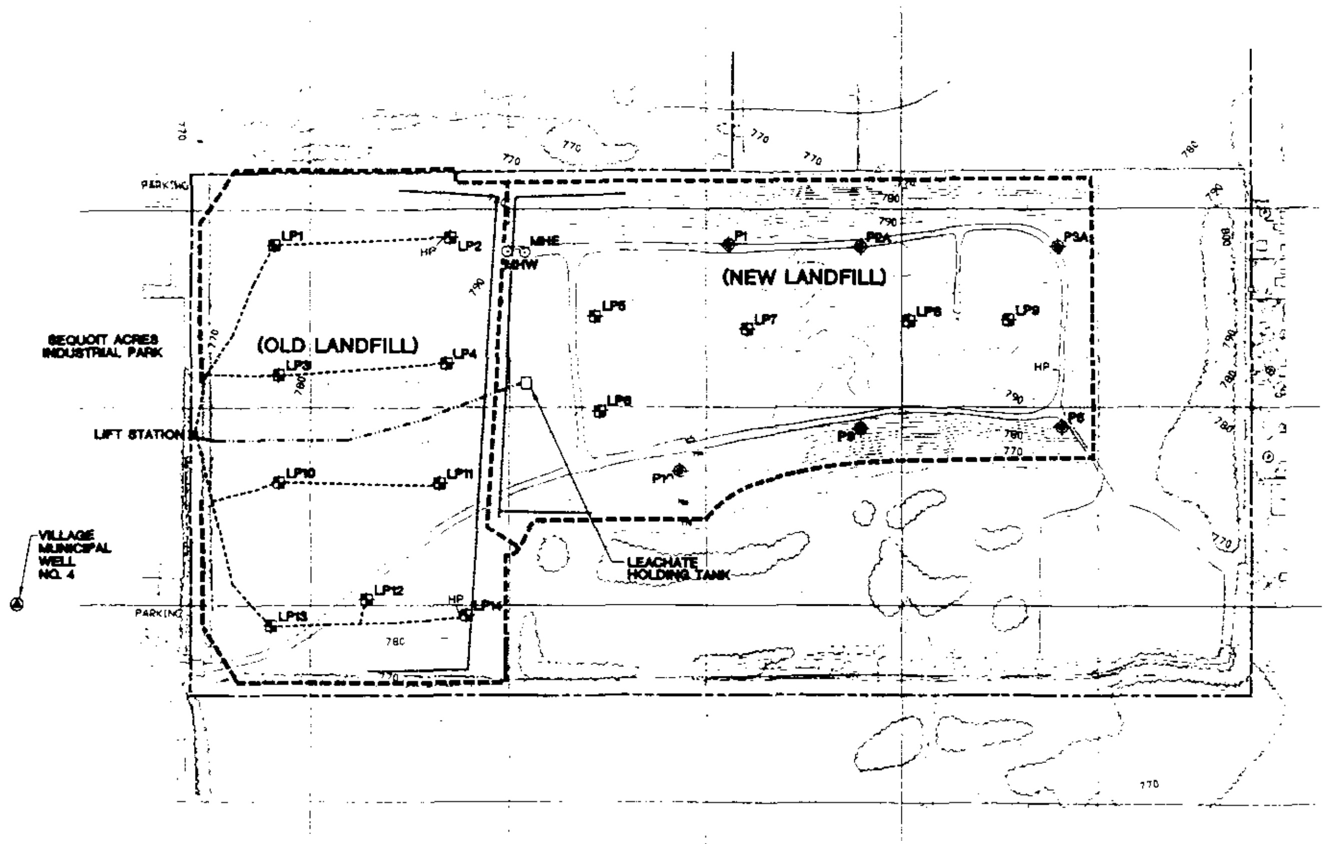
north

0 300 600

SCALE IN FEET

FIGURE 13

ALTERNATIVE LC2-TOE-OF-SLOPE LEACHATE COLLECTION	
FEASIBILITY STUDY H.O.D. LANDFILL WASTE MANAGEMENT OF ILLINOIS, INC. ANTIOCH, ILLINOIS	Developed By TST — Drawn By DKP Approved By TAB — Date 2/5/98 Reference J/1252/035/03090210/MWDWGS/B13.dwg Revisions
Drawing Number 1252035 03090210 B13	MONTGOMERY WATSON



LEGEND (EXISTING)

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- MHW/MHE LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- P2A LEACHATE EXTRACTION WELL LOCATION AND NUMBER
- LP8 LEACHATE PIEZOMETER LOCATION AND NUMBER
- EXISTING LEACHATE COLLECTION TOE DRAIN

LEGEND (PROPOSED)

- GAS/LEACHATE HEADER PIPING
- PROPOSED LEACHATE TRANSPORT PIPE

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

ALTERNATIVE LC3 PROPOSES

1. CONSTRUCTION OF NEW LEACHATE COLLECTION PIPING IN NEW LANDFILL AREA.
2. USE OF THE CURRENTLY-USED EXTRACTION DEVICES (MHE, MHW, P1, P2A, P3A, P8, P9, P10)
3. USE OF EXISTING WELLS (LP1-LP14)
4. INSTALL ADDITIONAL LEACHATE HEADER PIPING CONNECTING DUAL EXTRACTION WELLS TO A CENTRALLY LOCATED STORAGE/TREATMENT FACILITY.

north

0 300 600

SCALE IN FEET

FIGURE 14

ALTERNATIVE LC3-UPGRADE/SUPPLEMENTATION OF LEACHATE SYSTEM

FEASIBILITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

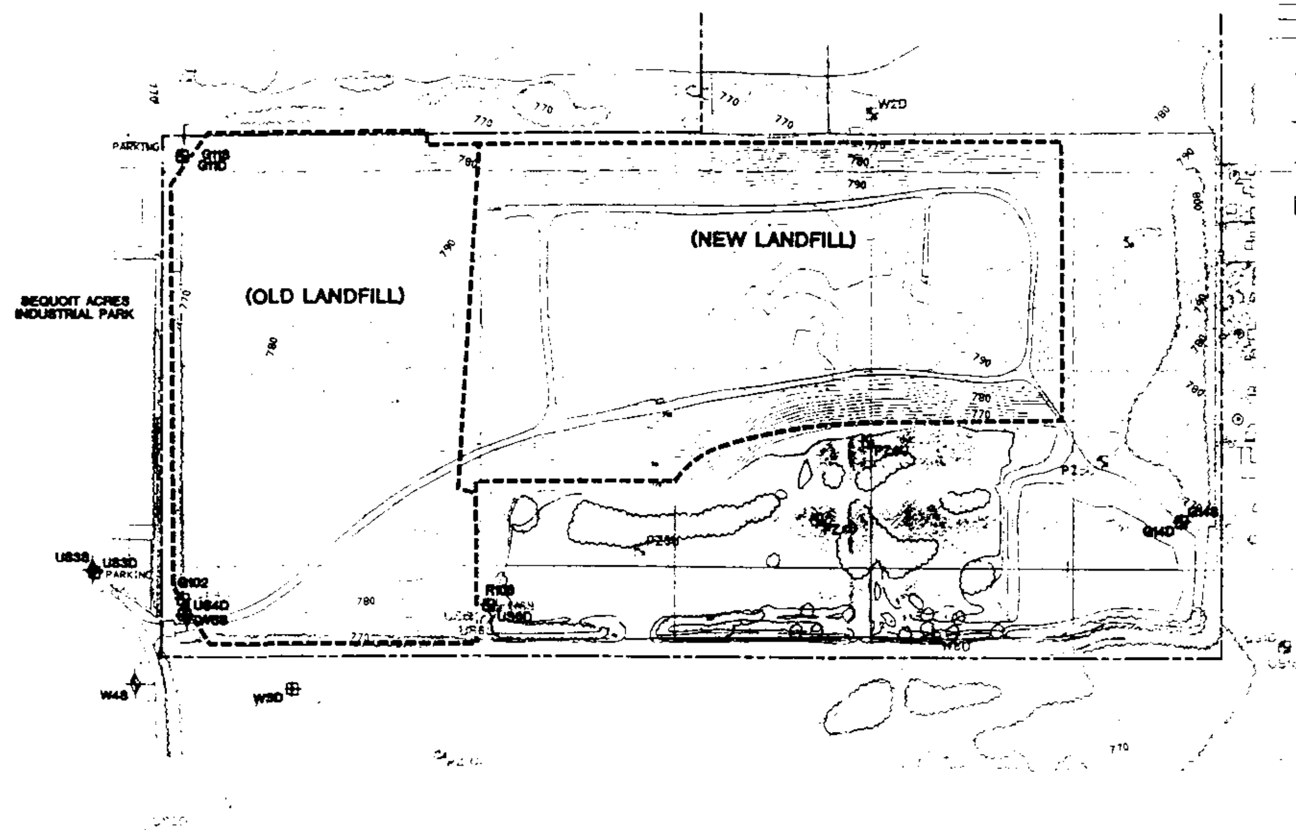
Developed By TST | Drawn By DKP
Approved By TAB | Date 2/5/98
Reference J/1252/035/0309021C/WINDWOS/B14.dwg
Revisions

Drawing Number 1252035 C3090210 B14

MONTGOMERY WATSON

QUALITY CONTROL | Graphic Standards DLF 3-19-97 | Lead Professional DRF 3-17-97 | Technical Review LAB 3-19-97 | Project Manager | Management Review | Other

QUALITY CONTROL	Graphic Standards	Technical Review	Management Review
	Lead Professional	Project Manager	Other



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- BUILDING
- FENCE LINE
- R103 PROPOSED SAMPLE LOCATION (IN CURRENT MONITORING PLAN)
- US3D PROPOSED SAMPLE LOCATION (NOT IN CURRENT MONITORING PLAN)
- US3D PROPOSED DOWNGRADIENT MONITORING NETWORK (NOT IN CURRENT MONITORING PLAN)
- APPROXIMATE AREA OF SEASONAL WETLAND (NOTE 3.)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC SURVEY, DATED JULY 21, 1993
2. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993
3. WETLAND AREA SHOWN HERE IS CONSISTENT WITH INFORMATION PRESENTED IN PELA H.O.D. LANDFILL WETLANDS ASSESSMENT, JULY 1993 AND JJR, INC. WETLAND IMITIGATION BANKING STUDY, JULY 1997.

north

0 300 600

SCALE IN FEET

FIGURE 15

SAMPLELOCATIONS-PROPOSED GROUNDWATER MONITORING PLAN

FEASIBITY STUDY
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By	TST	Drawn By	DKP
Approved By	TAB	Date	2/5/98
Reference			
Revisions			

Drawing Number 1252035 C3090210 B15

MONTGOMERY WATSON

A

APPENDIX A

CAPPING TIMING ESTIMATE

CAPPING TIMING

C1: *Assume 6,000 cubic yards/day can be moved, 6-day work week
*Assume only the top 3 feet of soil will be reworked

Top 3 feet = 246,840 cubic yards

$Time_{c1}$ = (246,840 cubic yards)/6,000 cubic yards/day = 42 days

Allow 25% for contingencies such as rain, equip. delays, etc. = 52.5 days, 9 weeks

C2: *Assume 6,000 cubic yards/day can be moved, 6-day work week

Total cover soils	=	274,270 cubic yards
Total clay	=	191,990 cubic yards
Total cap	=	466,260 cubic yards

$Time_{c2}$ = (466,260 cubic yards)/6,000 cubic yards/day = 78 days

Allow 25% for contingencies such as rain, equip. delays, etc. = 97.5 days, 17 weeks

C3: Supplemental Clay Option -
Same as C2 with addition of an extra 102,850 cu.yd. of clay

87 days + (102,850 cubic yards/6,000 cubic yards/day) = 105 days

Allow 25% for contingencies such as rain, equip. delays, etc. = 131.25 days, 22 weeks

C3: New Off-Site Clay Option -
Same as C2 with addition of an extra 250,000 cu.yd. of clay

87 days + (250,000 cubic yards/6,000 cubic yards/day) = 129 days

Allow 25% for contingencies such as rain, equip. delays, etc. = 161.25 days, 27 weeks

If the new off-site clay option is selected, cap construction will take more than one construction season.

B

APPENDIX B

HELP MODEL OUTPUT

Description of HELP Model Run Scenarios and Key Assumptions, and Summary of Results

The RI states that 1" per year of infiltration occurs under the existing conditions at the HOD site. The HELP model input used during the RI to arrive at 1" per year of infiltration was based on the following:

- a 28" thick cover soil layer of 10^{-4} cm/sec hydraulic conductivity
- a 43" thick compacted clay layer of 10^{-7} cm/sec hydraulic
- good vegetation
- a runoff curve # of 85 (which is high and relates more closely to 4H:1V sloped areas)

There are areas on the landfill that have been affected by erosion and settlement and therefore rills, gullies, and depressions have formed. These areas comprise 20% of the total Site area. These areas may currently have standing water, little to no vegetation, and eroded soils (i.e. soil cap loss).

Run 1: **Worst-case scenario for existing site conditions**, assumes:

- "depression area" on site
- clay cap (upper layer) integrity has been affected by root penetration, settlement, etc., so only bottom 12" is good
- SCS curve # of 60 assumed due to no slope, etc.
- hydraulic conductivity of 10^{-4} cm/sec for cover soil and 10^{-7} cm/s for compacted clay
- area is bare due to pooled water killing plants
- 0% runoff

Run 2: **Regrade of existing cover (807-compliant cap)**, assumes:

- no "depression areas" remaining on site
- clay cap integrity is restored
- SCS curve # of 70 assumed - slope improved by regrade
- hydraulic conductivity of 10^{-4} cm/sec for cover soil and 10^{-7} cm/s for compacted clay
- area is re-vegetated
- 80% runoff

Run 3: **Regrade and reconfiguration of existing cover materials to achieve 2' cover material & 2' compacted clay cap (807-compliant cap)**, assumes:

- same as Run 2 with different cap configuration, 100% runoff
- SCS curve # of 70 still assumed to be conservative

Run 4: **Regrade and reconfiguration of existing cover materials to achieve 3' cover material & 3' compacted clay cap (811-compliant cap)**, assumes:

- same as Run 3 with different cap configuration

Summary of Key Input Parameters and HELP Model Results

Parameter	Run 1	Run 2	Run 3	Run 4
Layer 1 Thickness (in.)	36	36	24	36
Layer 2 Thickness (in.)	12	24	24	36
SCS Curve #	60	70	70	70
% Runoff	0	80	100	100
Leaf Area Index	0	3	3	3
Evap. Zone Depth (in.)	8	12	12	12
Predicted Annual Infiltration (in./yr)	4.28345	2.48295	1.90003	2.07581

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************
```

```
PRECIPITATION DATA FILE:     C:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:       C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\DATA10.D10
OUTPUT DATA FILE:            C:\HELP3\RUN1.OUT
```

TIME: 8:46 DATE: 11/10/1997

```
******************************************************************************

     TITLE: HOD Landfill - Run 1

******************************************************************************
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	36.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3647 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.119999997000E-03 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	60.00
FRACTION OF AREA ALLOWING RUNOFF	=	0.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000 ACRES
EVAPORATIVE ZONE DEPTH	=	8.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.168 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.184 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.088 INCHES
INITIAL SNOW WATER	=	0.000 INCHES
INITIAL WATER IN LAYER MATERIALS	=	18.255 INCHES
TOTAL INITIAL WATER	=	18.255 INCHES
TOTAL SUBSURFACE INFLOW	=	0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHICAGO ILLINOIS

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	117
END OF GROWING SEASON (JULIAN DATE)	=	290
AVERAGE ANNUAL WIND SPEED	=	10.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00 %

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 65.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.60	1.31	2.59	3.66	3.15	4.08
3.63	3.53	3.35	2.28	2.06	2.10

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.40	26.00	36.00	48.80	59.10	68.60
73.00	71.90	64.70	53.50	39.80	27.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

STATION LATITUDE = 41.78 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.45	110533.531	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	25.260	91694.750	82.96
PERC./LEAKAGE THROUGH LAYER 2	3.896257	14143.412	12.80

AVG. HEAD ON TOP OF LAYER 2	25.6327		
CHANGE IN WATER STORAGE	1.293	4695.359	4.25
SOIL WATER AT START OF YEAR	18.255	66265.016	
SOIL WATER AT END OF YEAR	19.452	70610.469	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

****

****

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.90	130317.016	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	30.621	111153.711	85.29
PERC./LEAKAGE THROUGH LAYER 2	4.456618	16177.522	12.41
AVG. HEAD ON TOP OF LAYER 2	31.0689		
CHANGE IN WATER STORAGE	0.919	3335.714	2.56
SOIL WATER AT START OF YEAR	19.452	70610.469	
SOIL WATER AT END OF YEAR	17.462	63385.461	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.909	10560.722	8.10
ANNUAL WATER BUDGET BALANCE	-0.0964	-349.929	-0.27

****

****

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.40	161171.953	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	41.459	150497.922	93.38
PERC./LEAKAGE THROUGH LAYER 2	4.413971	16022.716	9.94
AVG. HEAD ON TOP OF LAYER 2	30.6739		
CHANGE IN WATER STORAGE	-1.473	-5348.562	-3.32
SOIL WATER AT START OF YEAR	17.462	63385.461	
SOIL WATER AT END OF YEAR	18.643	67674.875	
SNOW WATER AT START OF YEAR	2.909	10560.722	6.55
SNOW WATER AT END OF YEAR	0.254	922.749	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	-0.132	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.12	109335.602	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.978	97928.633	89.57
PERC./LEAKAGE THROUGH LAYER 2	4.100074	14883.270	13.61
AVG. HEAD ON TOP OF LAYER 2	27.5329		
CHANGE IN WATER STORAGE	-0.958	-3476.277	-3.18

SOIL WATER AT START OF YEAR	18.643	67674.875	
SOIL WATER AT END OF YEAR	17.940	65121.344	
SNOW WATER AT START OF YEAR	0.254	922.749	0.84
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.023	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.29	117212.703	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	28.479	103377.500	88.20
PERC./LEAKAGE THROUGH LAYER 2	4.179971	15173.294	12.95
AVG. HEAD ON TOP OF LAYER 2	28.4682		
CHANGE IN WATER STORAGE	-0.369	-1338.090	-1.14
SOIL WATER AT START OF YEAR	17.940	65121.344	
SOIL WATER AT END OF YEAR	17.571	63783.254	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.58	125525.437	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	29.810	108210.727	86.21
PERC./LEAKAGE THROUGH LAYER 2	4.109856	14918.777	11.89
AVG. HEAD ON TOP OF LAYER 2	27.6946		
CHANGE IN WATER STORAGE	0.660	2395.933	1.91
SOIL WATER AT START OF YEAR	17.571	63783.254	
SOIL WATER AT END OF YEAR	18.198	66057.898	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.033	121.284	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.24	127921.203	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	29.180	105921.812	82.80
PERC./LEAKAGE THROUGH LAYER 2	4.415914	16029.767	12.53
AVG. HEAD ON TOP OF LAYER 2	30.6853		
CHANGE IN WATER STORAGE	1.645	5969.643	4.67
SOIL WATER AT START OF YEAR	18.198	66057.898	
SOIL WATER AT END OF YEAR	19.452	70610.469	

SNOW WATER AT START OF YEAR	0.033	121.284	0.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.13	127521.930	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	28.753	104374.734	81.85
PERC./LEAKAGE THROUGH LAYER 2	4.544774	16497.529	12.94
AVG. HEAD ON TOP OF LAYER 2	31.7825		
CHANGE IN WATER STORAGE	2.256	8187.989	6.42
SOIL WATER AT START OF YEAR	19.452	70610.469	
SOIL WATER AT END OF YEAR	19.446	70587.844	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.413	1500.300	1.18
ANNUAL WATER BUDGET BALANCE	-0.4238	-1538.321	-1.21

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT

PRECIPITATION	38.61	140154.297	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	37.182	134972.437	96.30
PERC./LEAKAGE THROUGH LAYER 2	4.446719	16141.591	11.52
AVG. HEAD ON TOP OF LAYER 2	30.9825		
CHANGE IN WATER STORAGE	-1.171	-4249.387	-3.03
SOIL WATER AT START OF YEAR	19.446	70587.844	
SOIL WATER AT END OF YEAR	18.688	67838.758	
SNOW WATER AT START OF YEAR	0.413	1500.300	1.07
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-1.8486	-6710.345	-4.79

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.75	111622.523	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.551	96380.672	86.35
PERC./LEAKAGE THROUGH LAYER 2	4.180220	15174.197	13.59
AVG. HEAD ON TOP OF LAYER 2	28.3919		
CHANGE IN WATER STORAGE	0.019	67.617	0.06
SOIL WATER AT START OF YEAR	18.688	67838.758	
SOIL WATER AT END OF YEAR	18.707	67906.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.035	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.85	93835.500	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	21.941	79645.180	84.88
PERC./LEAKAGE THROUGH LAYER 2	4.195835	15230.880	16.23
AVG. HEAD ON TOP OF LAYER 2	28.5496		
CHANGE IN WATER STORAGE	-0.287	-1040.526	-1.11
SOIL WATER AT START OF YEAR	18.707	67906.375	
SOIL WATER AT END OF YEAR	17.999	65335.637	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.422	1530.207	1.63
ANNUAL WATER BUDGET BALANCE	0.0000	-0.031	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.81	104580.297	100.00
RUNOFF	0.000	0.000	0.00

EVAPOTRANSPIRATION	24.696	89647.000	85.72
PERC./LEAKAGE THROUGH LAYER 2	4.170919	15140.436	14.48
AVG. HEAD ON TOP OF LAYER 2	28.1881		
CHANGE IN WATER STORAGE	-0.057	-207.190	-0.20
SOIL WATER AT START OF YEAR	17.999	65335.637	
SOIL WATER AT END OF YEAR	18.363	66658.656	
SNOW WATER AT START OF YEAR	0.422	1530.207	1.46
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.048	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.56	114562.812	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.030	94490.305	82.48
PERC./LEAKAGE THROUGH LAYER 2	4.213274	15294.187	13.35
AVG. HEAD ON TOP OF LAYER 2	28.7080		
CHANGE IN WATER STORAGE	1.316	4778.356	4.17
SOIL WATER AT START OF YEAR	18.363	66658.656	
SOIL WATER AT END OF YEAR	19.452	70610.469	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	108.900	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.031	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.36	113836.836	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	25.261	91699.078	80.55
PERC./LEAKAGE THROUGH LAYER 2	4.317811	15673.652	13.77
AVG. HEAD ON TOP OF LAYER 2	29.7106		
CHANGE IN WATER STORAGE	1.978	7181.720	6.31
SOIL WATER AT START OF YEAR	19.452	70610.469	
SOIL WATER AT END OF YEAR	17.834	64738.941	
SNOW WATER AT START OF YEAR	0.030	108.900	0.10
SNOW WATER AT END OF YEAR	3.626	13162.146	11.56
ANNUAL WATER BUDGET BALANCE	-0.1977	-717.611	-0.63

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.36	88426.828	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	22.334	81070.805	91.68
PERC./LEAKAGE THROUGH LAYER 2	4.218378	15312.712	17.32

AVG. HEAD ON TOP OF LAYER 2	28.8117		
CHANGE IN WATER STORAGE	-2.192	-7956.739	-9.00
SOIL WATER AT START OF YEAR	17.834	64738.941	
SOIL WATER AT END OF YEAR	19.268	69944.352	
SNOW WATER AT START OF YEAR	3.626	13162.146	14.88
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.70	111440.992	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.425	95921.125	86.07
PERC./LEAKAGE THROUGH LAYER 2	4.218515	15313.209	13.74
AVG. HEAD ON TOP OF LAYER 2	28.6485		
CHANGE IN WATER STORAGE	0.057	206.720	0.19
SOIL WATER AT START OF YEAR	19.268	69944.352	
SOIL WATER AT END OF YEAR	19.325	70151.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.061	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.44	139537.187	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	33.433	121362.578	86.98
PERC./LEAKAGE THROUGH LAYER 2	4.375218	15882.043	11.38
AVG. HEAD ON TOP OF LAYER 2	30.2915		
CHANGE IN WATER STORAGE	0.632	2292.575	1.64
SOIL WATER AT START OF YEAR	19.325	70151.070	
SOIL WATER AT END OF YEAR	19.452	70610.469	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.051	183.479	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.91	90423.328	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	21.271	77212.055	85.39
PERC./LEAKAGE THROUGH LAYER 2	4.204359	15261.823	16.88
AVG. HEAD ON TOP OF LAYER 2	28.6219		
CHANGE IN WATER STORAGE	-0.110	-400.883	-0.44

SOIL WATER AT START OF YEAR	19.452	70610.469	
SOIL WATER AT END OF YEAR	19.392	70393.062	
SNOW WATER AT START OF YEAR	0.051	183.479	0.20
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.4545	-1649.668	-1.82

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.41	143058.250	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	31.925	115889.164	81.01
PERC./LEAKAGE THROUGH LAYER 2	4.558853	16548.635	11.57
AVG. HEAD ON TOP OF LAYER 2	32.0605		
CHANGE IN WATER STORAGE	2.926	10620.562	7.42
SOIL WATER AT START OF YEAR	19.392	70393.062	
SOIL WATER AT END OF YEAR	19.443	70577.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.073	263.842	0.18
ANNUAL WATER BUDGET BALANCE	0.0000	-0.119	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.99	127013.680	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	31.589	114668.422	90.28
PERC./LEAKAGE THROUGH LAYER 2	4.451557	16159.152	12.72
AVG. HEAD ON TOP OF LAYER 2	30.9036		
CHANGE IN WATER STORAGE	1.752	6358.402	5.01
SOIL WATER AT START OF YEAR	19.443	70577.562	
SOIL WATER AT END OF YEAR	19.452	70610.469	
SNOW WATER AT START OF YEAR	0.073	263.842	0.21
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-2.8023	-10172.302	-8.01

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.56	1.42	2.51	3.11	3.62	3.94
	3.78	2.92	3.50	2.24	2.23	2.08
STD. DEVIATIONS	0.64	0.65	1.40	1.67	1.86	2.09
	1.75	1.72	1.68	1.27	1.02	1.00
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

```
    STD. DEVIATIONS        0.000    0.000    0.000    0.000    0.000    0.000
                           0.000    0.000    0.000    0.000    0.000    0.000

  EVAPOTRANSPIRATION
  ------------------
    TOTALS                 0.712    0.914    2.362    3.736    3.753    3.750
                           3.595    2.859    2.557    2.132    1.241    0.849

    STD. DEVIATIONS        0.175    0.238    0.393    0.836    1.687    1.727
                           1.780    1.737    1.264    0.715    0.329    0.185

  PERCOLATION/LEAKAGE THROUGH LAYER  2
  ------------------------------------
    TOTALS                 0.3538   0.3225   0.3723   0.3671   0.3663   0.3457
                           0.3565   0.3529   0.3478   0.3696   0.3564   0.3725

    STD. DEVIATIONS        0.0358   0.0290   0.0326   0.0329   0.0343   0.0272
                           0.0245   0.0223   0.0242   0.0262   0.0318   0.0351


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            AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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  DAILY AVERAGE HEAD ACROSS LAYER  2
  ----------------------------------
    AVERAGES              27.9429  28.6345  30.3685  31.1645  29.6883  28.6502
                          28.5730  28.1567  28.8987  30.0631  29.9150  30.3892

    STD. DEVIATIONS        3.9768   3.6592   3.7064   3.8743   3.9089   3.1948
                           2.7840   2.5409   2.8492   2.9837   3.7359   3.9967

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   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   20
-------------------------------------------------------------------------------
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                                 INCHES           CU. FEET       PERCENT
                           -------------------  -------------  ---------
  PRECIPITATION              32.89   (  5.107)    119401.6      100.00

  RUNOFF                      0.000  ( 0.0000)         0.00       0.000

  EVAPOTRANSPIRATION         28.459  ( 5.0312)    103305.93      86.520
```

PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	4.28345 (	0.16986)	15548.941	13.02239
AVERAGE HEAD ACROSS TOP OF LAYER 2	29.370 (	1.640)		
CHANGE IN WATER STORAGE	0.442 (	1.3380)	1603.65	1.343

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	4.09	14846.700
RUNOFF	0.000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.013606	49.38987
AVERAGE HEAD ACROSS LAYER 2	36.000	
SNOW WATER	4.36	15834.7090
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3980
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1020

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	14.3279	0.3980
2	5.1240	0.4270
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.01  (14 OCTOBER 1994)                  **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE: C:\HELP3\DATAPR2.D4
TEMPERATURE DATA FILE: C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE: C:\HELP3\DATASR2.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\DATAER2.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\DATASDR2.D10
OUTPUT DATA FILE: C:\HELP3\RUN2.OUT

TIME: 13:57 DATE: 11/10/1997

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TITLE: HOD Landfill - Run 2

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	36.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL

```
  INITIAL SOIL WATER CONTENT  =       0.3325 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.119999997000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                          LAYER  2
                          --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  16
  THICKNESS                   =    24.00   INCHES
  POROSITY                    =     0.4270 VOL/VOL
  FIELD CAPACITY              =     0.4180 VOL/VOL
  WILTING POINT               =     0.3670 VOL/VOL
  INITIAL SOIL WATER CONTENT  =      0.4270 VOL/VOL
  EFFECTIVE SAT. HYD. COND.   =  0.100000001000E-06 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER              =     70.00
FRACTION OF AREA ALLOWING RUNOFF     =     80.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      3.366  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.776  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.632  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     22.219  INCHES
TOTAL INITIAL WATER                  =     22.219  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR


           EVAPOTRANSPIRATION AND WEATHER DATA
           -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       CHICAGO              ILLINOIS

    MAXIMUM LEAF AREA INDEX                 =  3.00
    START OF GROWING SEASON (JULIAN DATE)   =   117
    END OF GROWING SEASON (JULIAN DATE)     =   290
```

AVERAGE ANNUAL WIND SPEED = 10.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 65.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.60	1.31	2.59	3.66	3.15	4.08
3.63	3.53	3.35	2.28	2.06	2.10

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.40	26.00	36.00	48.80	59.10	68.60
73.00	71.90	64.70	53.50	39.80	27.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

STATION LATITUDE = 41.78 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.45	110533.531	100.00
RUNOFF	0.323	1173.879	1.06
EVAPOTRANSPIRATION	26.255	95304.781	86.22

PERC./LEAKAGE THROUGH LAYER 2	2.152707	7814.327	7.07
AVG. HEAD ON TOP OF LAYER 2	17.5999		
CHANGE IN WATER STORAGE	1.719	6240.510	5.65
SOIL WATER AT START OF YEAR	22.219	80653.773	
SOIL WATER AT END OF YEAR	23.938	86894.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.90	130317.016	100.00
RUNOFF	5.095	18493.670	14.19
EVAPOTRANSPIRATION	27.464	99693.156	76.50
PERC./LEAKAGE THROUGH LAYER 2	2.529513	9182.131	7.05
AVG. HEAD ON TOP OF LAYER 2	24.8948		
CHANGE IN WATER STORAGE	0.812	2948.106	2.26
SOIL WATER AT START OF YEAR	23.938	86894.281	
SOIL WATER AT END OF YEAR	21.841	79281.664	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.909	10560.722	8.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.041	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.40	161171.953	100.00
RUNOFF	7.891	28642.631	17.77
EVAPOTRANSPIRATION	35.301	128143.070	79.51
PERC./LEAKAGE THROUGH LAYER 2	2.509244	9108.558	5.65
AVG. HEAD ON TOP OF LAYER 2	24.4769		
CHANGE IN WATER STORAGE	-1.301	-4722.253	-2.93
SOIL WATER AT START OF YEAR	21.841	79281.664	
SOIL WATER AT END OF YEAR	23.195	84197.383	
SNOW WATER AT START OF YEAR	2.909	10560.722	6.55
SNOW WATER AT END OF YEAR	0.254	922.749	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	-0.053	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.12	109335.602	100.00
RUNOFF	2.761	10024.170	9.17
EVAPOTRANSPIRATION	26.864	97515.953	89.19
PERC./LEAKAGE THROUGH LAYER 2	2.300879	8352.192	7.64
AVG. HEAD ON TOP OF LAYER 2	20.3468		

CHANGE IN WATER STORAGE	-1.806	-6556.675	-6.00
SOIL WATER AT START OF YEAR	23.195	84197.383	
SOIL WATER AT END OF YEAR	21.643	78563.461	
SNOW WATER AT START OF YEAR	0.254	922.749	0.84
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.29	117212.703	100.00
RUNOFF	2.385	8657.686	7.39
EVAPOTRANSPIRATION	26.320	95542.562	81.51
PERC./LEAKAGE THROUGH LAYER 2	2.396497	8699.284	7.42
AVG. HEAD ON TOP OF LAYER 2	22.3064		
CHANGE IN WATER STORAGE	1.188	4313.214	3.68
SOIL WATER AT START OF YEAR	21.643	78563.461	
SOIL WATER AT END OF YEAR	22.831	82876.672	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.042	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.58	125525.437	100.00
RUNOFF	1.336	4850.396	3.86
EVAPOTRANSPIRATION	30.394	110330.789	87.90
PERC./LEAKAGE THROUGH LAYER 2	2.513202	9122.924	7.27
AVG. HEAD ON TOP OF LAYER 2	24.5667		
CHANGE IN WATER STORAGE	0.336	1221.234	0.97
SOIL WATER AT START OF YEAR	22.831	82876.672	
SOIL WATER AT END OF YEAR	23.134	83976.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.033	121.284	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.089	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.24	127921.203	100.00
RUNOFF	4.326	15704.122	12.28
EVAPOTRANSPIRATION	27.622	100268.953	78.38
PERC./LEAKAGE THROUGH LAYER 2	2.624393	9526.546	7.45
AVG. HEAD ON TOP OF LAYER 2	26.7137		
CHANGE IN WATER STORAGE	0.667	2421.561	1.89
SOIL WATER AT START OF YEAR	23.134	83976.625	

SOIL WATER AT END OF YEAR	23.835	86519.469	
SNOW WATER AT START OF YEAR	0.033	121.284	0.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.13	127521.930	100.00
RUNOFF	4.449	16149.851	12.66
EVAPOTRANSPIRATION	26.999	98005.312	76.85
PERC./LEAKAGE THROUGH LAYER 2	2.579539	9363.725	7.34
AVG. HEAD ON TOP OF LAYER 2	25.7170		
CHANGE IN WATER STORAGE	1.103	4003.015	3.14
SOIL WATER AT START OF YEAR	23.835	86519.469	
SOIL WATER AT END OF YEAR	24.524	89022.180	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.413	1500.300	1.18
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT

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PRECIPITATION	38.61	140154.297	100.00
RUNOFF	8.041	29189.738	20.83
EVAPOTRANSPIRATION	29.645	107612.500	76.78
PERC./LEAKAGE THROUGH LAYER 2	2.574242	9344.500	6.67
AVG. HEAD ON TOP OF LAYER 2	25.7541		
CHANGE IN WATER STORAGE	-1.651	-5992.443	-4.28
SOIL WATER AT START OF YEAR	24.524	89022.180	
SOIL WATER AT END OF YEAR	23.287	84530.039	
SNOW WATER AT START OF YEAR	0.413	1500.300	1.07
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
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PRECIPITATION	30.75	111622.523	100.00
RUNOFF	1.870	6787.464	6.08
EVAPOTRANSPIRATION	26.049	94559.117	84.71
PERC./LEAKAGE THROUGH LAYER 2	2.558250	9286.448	8.32
AVG. HEAD ON TOP OF LAYER 2	25.4417		
CHANGE IN WATER STORAGE	0.273	989.476	0.89
SOIL WATER AT START OF YEAR	23.287	84530.039	
SOIL WATER AT END OF YEAR	23.559	85519.516	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.85	93835.500	100.00
RUNOFF	2.317	8409.019	8.96
EVAPOTRANSPIRATION	21.901	79500.430	84.72
PERC./LEAKAGE THROUGH LAYER 2	2.446893	8882.224	9.47
AVG. HEAD ON TOP OF LAYER 2	23.2892		
CHANGE IN WATER STORAGE	-0.814	-2956.175	-3.15
SOIL WATER AT START OF YEAR	23.559	85519.516	
SOIL WATER AT END OF YEAR	22.323	81033.133	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.422	1530.207	1.63
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.81	104580.297	100.00
RUNOFF	0.692	2510.465	2.40

EVAPOTRANSPIRATION	25.013	90796.398	86.82
PERC./LEAKAGE THROUGH LAYER 2	2.473428	8978.543	8.59
AVG. HEAD ON TOP OF LAYER 2	23.6699		
CHANGE IN WATER STORAGE	0.632	2294.923	2.19
SOIL WATER AT START OF YEAR	22.323	81033.133	
SOIL WATER AT END OF YEAR	23.377	84858.266	
SNOW WATER AT START OF YEAR	0.422	1530.207	1.46
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.028	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.56	114562.812	100.00
RUNOFF	1.980	7188.721	6.27
EVAPOTRANSPIRATION	25.964	94249.430	82.27
PERC./LEAKAGE THROUGH LAYER 2	2.541749	9226.551	8.05
AVG. HEAD ON TOP OF LAYER 2	25.1299		
CHANGE IN WATER STORAGE	1.074	3898.050	3.40
SOIL WATER AT START OF YEAR	23.377	84858.266	
SOIL WATER AT END OF YEAR	24.451	88756.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	108.900	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.057	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.36	113836.836	100.00
RUNOFF	3.980	14446.475	12.69
EVAPOTRANSPIRATION	23.170	84107.141	73.88
PERC./LEAKAGE THROUGH LAYER 2	2.490315	9039.845	7.94
AVG. HEAD ON TOP OF LAYER 2	24.1140		
CHANGE IN WATER STORAGE	1.690	6134.452	5.39
SOIL WATER AT START OF YEAR	24.451	88756.312	
SOIL WATER AT END OF YEAR	22.545	81837.516	
SNOW WATER AT START OF YEAR	0.030	108.900	0.10
SNOW WATER AT END OF YEAR	3.626	13162.146	11.56
ANNUAL WATER BUDGET BALANCE	0.0300	108.923	0.10

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.36	88426.828	100.00
RUNOFF	3.091	11221.979	12.69
EVAPOTRANSPIRATION	21.078	76512.7[illegible]8	86.53
PERC./LEAKAGE THROUGH LAYER 2	2.421130	8788.703	9.94

AVG. HEAD ON TOP OF LAYER 2	22.7918		
CHANGE IN WATER STORAGE	-2.230	-8096.687	-9.16
SOIL WATER AT START OF YEAR	22.545	81837.516	
SOIL WATER AT END OF YEAR	23.940	86902.977	
SNOW WATER AT START OF YEAR	3.626	13162.146	14.88
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.079	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.70	111440.992	100.00
RUNOFF	0.806	2924.963	2.62
EVAPOTRANSPIRATION	27.183	98673.328	88.54
PERC./LEAKAGE THROUGH LAYER 2	2.513321	9123.354	8.19
AVG. HEAD ON TOP OF LAYER 2	24.4340		
CHANGE IN WATER STORAGE	0.198	719.349	0.65
SOIL WATER AT START OF YEAR	23.940	86902.977	
SOIL WATER AT END OF YEAR	24.138	87622.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.44	139537.187	100.00
RUNOFF	2.696	9785.800	7.01
EVAPOTRANSPIRATION	33.005	119807.547	85.86
PERC./LEAKAGE THROUGH LAYER 2	2.537162	9209.898	6.60
AVG. HEAD ON TOP OF LAYER 2	25.0330		
CHANGE IN WATER STORAGE	0.202	733.932	0.53
SOIL WATER AT START OF YEAR	24.138	87622.328	
SOIL WATER AT END OF YEAR	24.290	88172.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.051	183.479	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.91	90423.328	100.00
RUNOFF	2.541	9224.983	10.20
EVAPOTRANSPIRATION	21.226	77051.422	85.21
PERC./LEAKAGE THROUGH LAYER 2	2.419889	8784.196	9.71
AVG. HEAD ON TOP OF LAYER 2	22.7730		
CHANGE IN WATER STORAGE	-1.277	-4637.307	-5.13

SOIL WATER AT START OF YEAR	24.290	88172.781	
SOIL WATER AT END OF YEAR	23.063	83718.953	
SNOW WATER AT START OF YEAR	0.051	183.479	0.20
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.41	143058.250	100.00
RUNOFF	8.975	32578.230	22.77
EVAPOTRANSPIRATION	26.414	95883.344	67.02
PERC./LEAKAGE THROUGH LAYER 2	2.518045	9140.503	6.39
AVG. HEAD ON TOP OF LAYER 2	24.6637		
CHANGE IN WATER STORAGE	1.503	5456.225	3.81
SOIL WATER AT START OF YEAR	23.063	83718.953	
SOIL WATER AT END OF YEAR	24.493	88911.336	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.073	263.842	0.18
ANNUAL WATER BUDGET BALANCE	0.0000	-0.059	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.99	127013.680	100.00
RUNOFF	6.452	23420.262	18.44
EVAPOTRANSPIRATION	25.973	94283.664	74.23
PERC./LEAKAGE THROUGH LAYER 2	2.558562	9287.581	7.31
AVG. HEAD ON TOP OF LAYER 2	25.3154		
CHANGE IN WATER STORAGE	0.006	22.196	0.02
SOIL WATER AT START OF YEAR	24.493	88911.336	
SOIL WATER AT END OF YEAR	24.572	89197.375	
SNOW WATER AT START OF YEAR	0.073	263.842	0.21
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.024	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.56	1.42	2.51	3.11	3.62	3.94
	3.78	2.92	3.50	2.24	2.23	2.08
STD. DEVIATIONS	0.64	0.65	1.40	1.67	1.86	2.09
	1.75	1.72	1.68	1.27	1.02	1.00
RUNOFF						
TOTALS	0.471	0.688	1.039	0.318	0.214	0.143
	0.076	0.003	0.130	0.000	0.217	0.301

STD. DEVIATIONS	0.624	0.596	1.042	0.540	0.669	0.533
	0.246	0.011	0.409	0.000	0.472	0.471

EVAPOTRANSPIRATION

TOTALS	0.641	0.798	2.078	3.052	3.506	3.986
	3.670	2.431	2.838	1.998	0.998	0.696
STD. DEVIATIONS	0.113	0.191	0.389	0.676	1.300	1.422
	1.674	1.464	1.080	0.620	0.212	0.134

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	0.2038	0.1781	0.2012	0.2133	0.2207	0.2044
	0.2077	0.2046	0.2044	0.2143	0.2120	0.2185
STD. DEVIATIONS	0.0092	0.0075	0.0132	0.0206	0.0167	0.0117
	0.0136	0.0124	0.0170	0.0138	0.0204	0.0165

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 2

AVERAGES	22.0096	20.8911	21.7928	26.1601	26.2333	24.0631
	23.2842	22.5731	24.0646	24.7693	25.8540	25.7240
STD. DEVIATIONS	1.8269	1.8812	3.0152	4.8439	3.8115	2.7622
	3.0849	2.8210	3.9935	3.1496	4.7871	3.7444

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.89	(5.107)	119401.6	100.00
RUNOFF	3.600	(2.5397)	13069.22	10.946
EVAPOTRANSPIRATION	26.692	(3.5516)	96892.08	81.148

PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	2.48295	(0.10768)	9013.101	7.54856
AVERAGE HEAD ACROSS TOP OF LAYER 2	23.952	(2.081)		
CHANGE IN WATER STORAGE	0.116	(1.2205)	421.74	0.353

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	4.09	14846.700
RUNOFF	1.454	5278.9253
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.008504	30.86869
AVERAGE HEAD ACROSS LAYER 2	36.000	
SNOW WATER	4.36	15834.7090
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3980	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1076	

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	14.3243	0.3979
2	10.2480	0.4270
SNOW WATER	0.000	

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**             HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                  **
**             DEVELOPED BY ENVIRONMENTAL LABORATORY                        **
**             USAE WATERWAYS EXPERIMENT STATION                            **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\DATAPR3.D4
TEMPERATURE DATA FILE:       C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DATASR3.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DATAER3.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\DATAR3.D10
OUTPUT DATA FILE:            C:\HELP3\RUN3.OUT
```

TIME: 12: 3   DATE: 11/10/1997

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  TITLE:  HOD Landfill - Run 3

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS          =   24.00   INCHES
POROSITY           =    0.3980 VOL/VOL
FIELD CAPACITY     =    0.2440 VOL/VOL
WILTING POINT      =    0.1360 VOL/VOL
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INITIAL SOIL WATER CONTENT = 0.3742 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.119999997000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.20
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS = 24.00 INCHES
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER = 70.00
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 1.000 ACRES
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE = 4.272 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE = 4.776 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.632 INCHES
INITIAL SNOW WATER = 0.000 INCHES
INITIAL WATER IN LAYER MATERIALS = 19.229 INCHES
TOTAL INITIAL WATER = 19.229 INCHES
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHICAGO ILLINOIS

MAXIMUM LEAF AREA INDEX = 3.00
START OF GROWING SEASON (JULIAN DATE) = 117
END OF GROWING SEASON (JULIAN DATE) = 290

AVERAGE ANNUAL WIND SPEED = 10.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 65.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.60	1.31	2.59	3.66	3.15	4.08
3.63	3.53	3.35	2.28	2.06	2.10

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.40	26.00	36.00	48.80	59.10	68.60
73.00	71.90	64.70	53.50	39.80	27.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

STATION LATITUDE = 41.78 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.45	110533.531	100.00
RUNOFF	0.542	1967.854	1.78
EVAPOTRANSPIRATION	27.909	101309.336	91.65

PERC./LEAKAGE THROUGH LAYER 2	1.851148	6719.669	6.08
AVG. HEAD ON TOP OF LAYER 2	11.7753		
CHANGE IN WATER STORAGE	0.148	536.619	0.49
SOIL WATER AT START OF YEAR	19.229	69802.430	
SOIL WATER AT END OF YEAR	19.377	70339.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.056	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.90	130317.016	100.00
RUNOFF	5.946	21584.195	16.56
EVAPOTRANSPIRATION	27.350	99281.609	76.18
PERC./LEAKAGE THROUGH LAYER 2	1.917299	6959.796	5.34
AVG. HEAD ON TOP OF LAYER 2	13.0602		
CHANGE IN WATER STORAGE	0.686	2491.400	1.91
SOIL WATER AT START OF YEAR	19.377	70339.047	
SOIL WATER AT END OF YEAR	17.154	62269.723	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.909	10560.722	8.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.40	161171.953	100.00
RUNOFF	8.758	31791.025	19.72
EVAPOTRANSPIRATION	34.928	126788.586	78.67
PERC./LEAKAGE THROUGH LAYER 2	1.918728	6964.982	4.32
AVG. HEAD ON TOP OF LAYER 2	13.0668		
CHANGE IN WATER STORAGE	-1.205	-4372.608	-2.71
SOIL WATER AT START OF YEAR	17.154	62269.723	
SOIL WATER AT END OF YEAR	18.605	67535.086	
SNOW WATER AT START OF YEAR	2.909	10560.722	6.55
SNOW WATER AT END OF YEAR	0.254	922.749	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.12	109335.602	100.00
RUNOFF	3.203	11627.953	10.64
EVAPOTRANSPIRATION	26.855	97483.617	89.16
PERC./LEAKAGE THROUGH LAYER 2	1.751127	6356.590	5.81
AVG. HEAD ON TOP OF LAYER 2	9.7515		

CHANGE IN WATER STORAGE	-1.689	-6132.545	-5.61
SOIL WATER AT START OF YEAR	18.605	67535.086	
SOIL WATER AT END OF YEAR	17.170	62325.293	
SNOW WATER AT START OF YEAR	0.254	922.749	0.84
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.009	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.29	117212.703	100.00
RUNOFF	2.770	10055.228	8.58
EVAPOTRANSPIRATION	26.601	96562.523	82.38
PERC./LEAKAGE THROUGH LAYER 2	1.827777	6634.829	5.66
AVG. HEAD ON TOP OF LAYER 2	11.3213		
CHANGE IN WATER STORAGE	1.091	3960.162	3.38
SOIL WATER AT START OF YEAR	17.170	62325.293	
SOIL WATER AT END OF YEAR	18.260	66285.453	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.038	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.58	125525.437	100.00
RUNOFF	1.765	6407.250	5.10
EVAPOTRANSPIRATION	30.583	111015.289	88.44
PERC./LEAKAGE THROUGH LAYER 2	1.923610	6982.705	5.56
AVG. HEAD ON TOP OF LAYER 2	13.1743		
CHANGE IN WATER STORAGE	0.309	1120.121	0.89
SOIL WATER AT START OF YEAR	18.260	66285.453	
SOIL WATER AT END OF YEAR	18.536	67284.289	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.033	121.284	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.073	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.24	127921.203	100.00
RUNOFF	4.937	17920.271	14.01
EVAPOTRANSPIRATION	27.707	100575.773	78.62
PERC./LEAKAGE THROUGH LAYER 2	2.018249	7326.245	5.73
AVG. HEAD ON TOP OF LAYER 2	14.9985		
CHANGE IN WATER STORAGE	0.578	2098.904	1.64
SOIL WATER AT START OF YEAR	18.536	67284.289	

SOIL WATER AT END OF YEAR	19.147	69504.477	
SNOW WATER AT START OF YEAR	0.033	121.284	0.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.13	127521.930	100.00
RUNOFF	5.174	18782.730	14.73
EVAPOTRANSPIRATION	27.030	98117.109	76.94
PERC./LEAKAGE THROUGH LAYER 2	1.968864	7146.978	5.60
AVG. HEAD ON TOP OF LAYER 2	13.9455		
CHANGE IN WATER STORAGE	0.957	3475.064	2.73
SOIL WATER AT START OF YEAR	19.147	69504.477	
SOIL WATER AT END OF YEAR	19.691	71479.242	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.413	1500.300	1.18
ANNUAL WATER BUDGET BALANCE	0.0000	0.050	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT

PRECIPITATION	38.61	140154.297	100.00
RUNOFF	8.356	30331.947	21.64
EVAPOTRANSPIRATION	29.740	107957.969	77.03
PERC./LEAKAGE THROUGH LAYER 2	1.942371	7050.808	5.03
AVG. HEAD ON TOP OF LAYER 2	13.5363		
CHANGE IN WATER STORAGE	-1.429	-5186.424	-3.70
SOIL WATER AT START OF YEAR	19.691	71479.242	
SOIL WATER AT END OF YEAR	18.676	67793.117	
SNOW WATER AT START OF YEAR	0.413	1500.300	1.07
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.75	111622.523	100.00
RUNOFF	2.407	8737.758	7.83
EVAPOTRANSPIRATION	26.109	94776.961	84.91
PERC./LEAKAGE THROUGH LAYER 2	1.961390	7119.848	6.38
AVG. HEAD ON TOP OF LAYER 2	13.9059		
CHANGE IN WATER STORAGE	0.272	987.946	0.89
SOIL WATER AT START OF YEAR	18.676	67793.117	
SOIL WATER AT END OF YEAR	18.948	68781.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.85	93835.500	100.00
RUNOFF	2.753	9992.193	10.65
EVAPOTRANSPIRATION	22.001	79864.687	85.11
PERC./LEAKAGE THROUGH LAYER 2	1.850534	6717.439	7.16
AVG. HEAD ON TOP OF LAYER 2	11.7621		
CHANGE IN WATER STORAGE	-0.754	-2738.793	-2.92
SOIL WATER AT START OF YEAR	18.948	68781.070	
SOIL WATER AT END OF YEAR	17.772	64512.066	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.422	1530.207	1.63
ANNUAL WATER BUDGET BALANCE	0.0000	-0.026	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.81	104580.297	100.00
RUNOFF	0.856	3107.942	2.97

EVAPOTRANSPIRATION	25.259	91690.922	87.68
PERC./LEAKAGE THROUGH LAYER 2	1.905233	6915.996	6.61
AVG. HEAD ON TOP OF LAYER 2	12.7178		
CHANGE IN WATER STORAGE	0.789	2865.461	2.74
SOIL WATER AT START OF YEAR	17.772	64512.066	
SOIL WATER AT END OF YEAR	18.983	68907.734	
SNOW WATER AT START OF YEAR	0.422	1530.207	1.46
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.021	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.56	114562.812	100.00
RUNOFF	2.875	10437.805	9.11
EVAPOTRANSPIRATION	26.057	94586.922	82.56
PERC./LEAKAGE THROUGH LAYER 2	1.953645	7091.732	6.19
AVG. HEAD ON TOP OF LAYER 2	13.7615		
CHANGE IN WATER STORAGE	0.674	2446.335	2.14
SOIL WATER AT START OF YEAR	18.983	68907.734	
SOIL WATER AT END OF YEAR	19.657	71354.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	108.900	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.36	113836.836	100.00
RUNOFF	4.427	16069.918	14.12
EVAPOTRANSPIRATION	23.125	83942.453	73.74
PERC./LEAKAGE THROUGH LAYER 2	1.893125	6872.042	6.04
AVG. HEAD ON TOP OF LAYER 2	12.5704		
CHANGE IN WATER STORAGE	1.885	6843.512	6.01
SOIL WATER AT START OF YEAR	19.657	71354.070	
SOIL WATER AT END OF YEAR	17.946	65144.336	
SNOW WATER AT START OF YEAR	0.030	108.900	0.10
SNOW WATER AT END OF YEAR	3.626	13162.146	11.56
ANNUAL WATER BUDGET BALANCE	0.0300	108.908	0.10

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.36	88426.828	100.00
RUNOFF	3.601	13070.091	14.78
EVAPOTRANSPIRATION	21.021	76307.945	86.30
PERC./LEAKAGE THROUGH LAYER 2	1.830633	6645.198	7.51

AVG. HEAD ON TOP OF LAYER 2	11.3752		
CHANGE IN WATER STORAGE	-2.093	-7596.473	-8.59
SOIL WATER AT START OF YEAR	17.946	65144.336	
SOIL WATER AT END OF YEAR	19.479	70710.008	
SNOW WATER AT START OF YEAR	3.626	13162.146	14.88
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.067	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.70	111440.992	100.00
RUNOFF	1.234	4477.848	4.02
EVAPOTRANSPIRATION	27.478	99746.781	89.51
PERC./LEAKAGE THROUGH LAYER 2	1.919584	6968.091	6.25
AVG. HEAD ON TOP OF LAYER 2	12.9907		
CHANGE IN WATER STORAGE	0.068	248.290	0.22
SOIL WATER AT START OF YEAR	19.479	70710.008	
SOIL WATER AT END OF YEAR	19.548	70958.297	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.44	139537.187	100.00
RUNOFF	3.473	12607.802	9.04
EVAPOTRANSPIRATION	33.071	120049.430	86.03
PERC./LEAKAGE THROUGH LAYER 2	1.916213	6955.854	4.98
AVG. HEAD ON TOP OF LAYER 2	13.0245		
CHANGE IN WATER STORAGE	-0.021	-75.978	-0.05
SOIL WATER AT START OF YEAR	19.548	70958.297	
SOIL WATER AT END OF YEAR	19.476	70698.844	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.051	183.479	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.087	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.91	90423.328	100.00
RUNOFF	3.088	11208.989	12.40
EVAPOTRANSPIRATION	21.231	77069.430	85.23
PERC./LEAKAGE THROUGH LAYER 2	1.809396	6568.106	7.26
AVG. HEAD ON TOP OF LAYER 2	10.9726		
CHANGE IN WATER STORAGE	-1.219	-4423.234	-4.89

SOIL WATER AT START OF YEAR	19.476	70698.844	
SOIL WATER AT END OF YEAR	18.308	66459.086	
SNOW WATER AT START OF YEAR	0.051	183.479	0.20
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.032	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.41	143058.250	100.00
RUNOFF	9.669	35099.371	24.54
EVAPOTRANSPIRATION	26.475	96103.258	67.18
PERC./LEAKAGE THROUGH LAYER 2	1.918031	6962.454	4.87
AVG. HEAD ON TOP OF LAYER 2	13.0734		
CHANGE IN WATER STORAGE	1.348	4893.178	3.42
SOIL WATER AT START OF YEAR	18.308	66459.086	
SOIL WATER AT END OF YEAR	19.584	71088.422	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.073	263.842	0.18
ANNUAL WATER BUDGET BALANCE	0.0000	-0.022	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.99	127013.680	100.00
RUNOFF	7.273	26400.865	20.79
EVAPOTRANSPIRATION	25.696	93276.289	73.44
PERC./LEAKAGE THROUGH LAYER 2	1.923571	6982.562	5.50
AVG. HEAD ON TOP OF LAYER 2	13.0704		
CHANGE IN WATER STORAGE	0.098	354.033	0.28
SOIL WATER AT START OF YEAR	19.584	71088.422	
SOIL WATER AT END OF YEAR	19.754	71706.297	
SNOW WATER AT START OF YEAR	0.073	263.842	0.21
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.071	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.56	1.42	2.51	3.11	3.62	3.94
	3.78	2.92	3.50	2.24	2.23	2.08
STD. DEVIATIONS	0.64	0.65	1.40	1.67	1.86	2.09
	1.75	1.72	1.68	1.27	1.02	1.00
RUNOFF						
TOTALS	0.569	0.821	1.194	0.306	0.244	0.163
	0.079	0.007	0.155	0.000	0.242	0.377

STD. DEVIATIONS	0.726	0.695	1.180	0.520	0.735	0.591
	0.247	0.027	0.480	0.000	0.527	0.545

EVAPOTRANSPIRATION

TOTALS	0.641	0.797	2.060	2.997	3.544	4.030
	3.673	2.439	2.884	2.038	1.013	0.697
STD. DEVIATIONS	0.112	0.190	0.392	0.701	1.186	1.403
	1.671	1.470	1.065	0.624	0.214	0.136

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	0.1539	0.1342	0.1514	0.1643	0.1703	0.1561
	0.1581	0.1559	0.1573	0.1650	0.1645	0.1690
STD. DEVIATIONS	0.0044	0.0030	0.0094	0.0155	0.0130	0.0082
	0.0100	0.0089	0.0149	0.0129	0.0194	0.0153

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 2

AVERAGES	10.7434	9.8088	10.4580	14.6438	14.7615	12.7190
	11.9882	11.4907	12.9892	13.5583	14.6876	14.4639
STD. DEVIATIONS	0.7841	0.7621	2.1373	3.6358	2.9608	1.9275
	2.2829	2.0285	3.5086	2.9252	4.5526	3.4819

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.89	(5.107)	119401.6	100.00
RUNOFF	4.155	(2.6504)	15083.95	12.633
EVAPOTRANSPIRATION	26.811	(3.5312)	97325.34	81.511

PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	1.90003 (0.06292)	6897.096	5.77638
AVERAGE HEAD ACROSS TOP OF LAYER 2	12.693 (1.217)		
CHANGE IN WATER STORAGE	0.025 (1.0842)	89.75	0.075

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	4.09	14846.700
RUNOFF	1.791	6502.5391
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.006803	24.69493
AVERAGE HEAD ACROSS LAYER 2	24.000	
SNOW WATER	4.36	15834.7090
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3980	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1078	

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	9.5058	0.3961
2	10.2480	0.4270
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\DATAPR4.D4
TEMPERATURE DATA FILE:       C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DATASR4.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DATAER4.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\DATASD4.D10
OUTPUT DATA FILE:            C:\HELP3\RUN4.OUT


TIME: 12:39    DATE: 11/10/1997


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    TITLE: HOD Landfill - Run 4

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    NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
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                    TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER 10
          THICKNESS                 =    36.00   INCHES
          POROSITY                  =     0.3980 VOL/VOL
          FIELD CAPACITY            =     0.2440 VOL/VOL
          WILTING POINT             =     0.1360 VOL/VOL
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INITIAL SOIL WATER CONTENT = 0.3341 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.119999997000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.20
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	70.00
FRACTION OF AREA ALLOWING RUNOFF	=	100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000 ACRES
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.363 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.776 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.632 INCHES
INITIAL SNOW WATER	=	0.000 INCHES
INITIAL WATER IN LAYER MATERIALS	=	27.401 INCHES
TOTAL INITIAL WATER	=	27.401 INCHES
TOTAL SUBSURFACE INFLOW	=	0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHICAGO ILLINOIS

MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	117
END OF GROWING SEASON (JULIAN DATE)	=	290

AVERAGE ANNUAL WIND SPEED = 10.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 65.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.60	1.31	2.59	3.66	3.15	4.08
3.63	3.53	3.35	2.28	2.06	2.10

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
21.40	26.00	36.00	48.80	59.10	68.60
73.00	71.90	64.70	53.50	39.80	27.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHICAGO ILLINOIS

STATION LATITUDE = 41.78 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.45	110533.531	100.00
RUNOFF	0.433	1571.591	1.42
EVAPOTRANSPIRATION	26.259	95319.883	86.24

PERC./LEAKAGE THROUGH LAYER 2	1.878705	6819.698	6.17
AVG. HEAD ON TOP OF LAYER 2	18.4614		
CHANGE IN WATER STORAGE	1.879	6822.348	6.17
SOIL WATER AT START OF YEAR	27.401	99466.680	
SOIL WATER AT END OF YEAR	29.281	106289.023	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.90	130317.016	100.00
RUNOFF	6.092	22114.961	16.97
EVAPOTRANSPIRATION	27.062	98234.531	75.38
PERC./LEAKAGE THROUGH LAYER 2	2.102785	7633.110	5.86
AVG. HEAD ON TOP OF LAYER 2	24.9694		
CHANGE IN WATER STORAGE	0.643	2334.385	1.79
SOIL WATER AT START OF YEAR	29.281	106289.023	
SOIL WATER AT END OF YEAR	27.015	98062.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.909	10560.722	8.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.036	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.40	161171.953	100.00
RUNOFF	8.729	31684.717	19.66
EVAPOTRANSPIRATION	34.858	126533.633	78.51
PERC./LEAKAGE THROUGH LAYER 2	2.092559	7595.989	4.71
AVG. HEAD ON TOP OF LAYER 2	24.6525		
CHANGE IN WATER STORAGE	−1.279	−4642.347	−2.88
SOIL WATER AT START OF YEAR	27.015	98062.687	
SOIL WATER AT END OF YEAR	28.391	103058.312	
SNOW WATER AT START OF YEAR	2.909	10560.722	6.55
SNOW WATER AT END OF YEAR	0.254	922.749	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	−0.039	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.12	109335.602	100.00
RUNOFF	3.198	11609.912	10.62
EVAPOTRANSPIRATION	26.746	97089.586	88.80
PERC./LEAKAGE THROUGH LAYER 2	1.961381	7119.812	6.51
AVG. HEAD ON TOP OF LAYER 2	20.7105		

CHANGE IN WATER STORAGE	-1.786	-6483.693	-5.93
SOIL WATER AT START OF YEAR	28.391	103058.312	
SOIL WATER AT END OF YEAR	26.859	97497.367	
SNOW WATER AT START OF YEAR	0.254	922.749	0.84
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.29	117212.703	100.00
RUNOFF	2.765	10038.568	8.56
EVAPOTRANSPIRATION	26.310	95506.383	81.48
PERC./LEAKAGE THROUGH LAYER 2	2.024077	7347.400	6.27
AVG. HEAD ON TOP OF LAYER 2	22.6744		
CHANGE IN WATER STORAGE	1.190	4320.332	3.69
SOIL WATER AT START OF YEAR	26.859	97497.367	
SOIL WATER AT END OF YEAR	28.049	101817.703	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.58	125525.437	100.00
RUNOFF	1.565	5679.735	4.52
EVAPOTRANSPIRATION	30.541	110864.945	88.32
PERC./LEAKAGE THROUGH LAYER 2	2.101687	7629.125	6.08
AVG. HEAD ON TOP OF LAYER 2	24.9285		
CHANGE IN WATER STORAGE	0.372	1351.600	1.08
SOIL WATER AT START OF YEAR	28.049	101817.703	
SOIL WATER AT END OF YEAR	28.388	103048.016	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.033	121.284	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.24	127921.203	100.00
RUNOFF	4.834	17549.168	13.72
EVAPOTRANSPIRATION	27.627	100284.461	78.40
PERC./LEAKAGE THROUGH LAYER 2	2.168575	7871.927	6.15
AVG. HEAD ON TOP OF LAYER 2	26.8636		
CHANGE IN WATER STORAGE	0.610	2215.602	1.73
SOIL WATER AT START OF YEAR	28.388	103048.016	

SOIL WATER AT END OF YEAR	29.032	105384.906	
SNOW WATER AT START OF YEAR	0.033	121.284	0.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.13	127521.930	100.00
RUNOFF	5.104	18526.187	14.53
EVAPOTRANSPIRATION	26.928	97748.148	76.65
PERC./LEAKAGE THROUGH LAYER 2	2.137847	7760.384	6.09
AVG. HEAD ON TOP OF LAYER 2	25.8094		
CHANGE IN WATER STORAGE	0.961	3487.167	2.73
SOIL WATER AT START OF YEAR	29.032	105384.906	
SOIL WATER AT END OF YEAR	29.579	107371.773	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.413	1500.300	1.18
ANNUAL WATER BUDGET BALANCE	0.0000	0.047	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT

PRECIPITATION	38.61	140154.297	100.00
RUNOFF	8.278	30049.793	21.44
EVAPOTRANSPIRATION	29.686	107758.789	76.89
PERC./LEAKAGE THROUGH LAYER 2	2.117731	7687.363	5.48
AVG. HEAD ON TOP OF LAYER 2	25.3939		
CHANGE IN WATER STORAGE	-1.472	-5341.618	-3.81
SOIL WATER AT START OF YEAR	29.579	107371.773	
SOIL WATER AT END OF YEAR	28.521	103530.453	
SNOW WATER AT START OF YEAR	0.413	1500.300	1.07
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.75	111622.523	100.00
RUNOFF	2.298	8340.419	7.47
EVAPOTRANSPIRATION	26.031	94491.203	84.65
PERC./LEAKAGE THROUGH LAYER 2	2.130400	7733.353	6.93
AVG. HEAD ON TOP OF LAYER 2	25.7633		
CHANGE IN WATER STORAGE	0.291	1057.522	0.95
SOIL WATER AT START OF YEAR	28.521	103530.453	
SOIL WATER AT END OF YEAR	28.812	104587.977	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.026	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.85	93835.500	100.00
RUNOFF	2.731	9914.817	10.57
EVAPOTRANSPIRATION	21.827	79232.664	84.44
PERC./LEAKAGE THROUGH LAYER 2	2.055911	7462.957	7.95
AVG. HEAD ON TOP OF LAYER 2	23.6032		
CHANGE IN WATER STORAGE	-0.764	-2774.920	-2.96
SOIL WATER AT START OF YEAR	28.812	104587.977	
SOIL WATER AT END OF YEAR	27.626	100282.852	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.422	1530.207	1.63
ANNUAL WATER BUDGET BALANCE	0.0000	-0.020	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.81	104580.297	100.00
RUNOFF	0.850	3086.278	2.95

EVAPOTRANSPIRATION	25.172	91372.844	87.37
PERC./LEAKAGE THROUGH LAYER 2	2.086322	7573.347	7.24
AVG. HEAD ON TOP OF LAYER 2	24.3179		
CHANGE IN WATER STORAGE	0.702	2547.810	2.44
SOIL WATER AT START OF YEAR	27.626	100282.852	
SOIL WATER AT END OF YEAR	28.750	104360.867	
SNOW WATER AT START OF YEAR	0.422	1530.207	1.46
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.56	114562.812	100.00
RUNOFF	2.655	9637.593	8.41
EVAPOTRANSPIRATION	25.985	94326.469	82.34
PERC./LEAKAGE THROUGH LAYER 2	2.121946	7702.665	6.72
AVG. HEAD ON TOP OF LAYER 2	25.5244		
CHANGE IN WATER STORAGE	0.798	2896.063	2.53
SOIL WATER AT START OF YEAR	28.750	104360.867	
SOIL WATER AT END OF YEAR	29.547	107256.930	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.030	108.900	0.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.36	113836.836	100.00
RUNOFF	4.348	15784.256	13.87
EVAPOTRANSPIRATION	23.078	83771.344	73.59
PERC./LEAKAGE THROUGH LAYER 2	2.081307	7555.146	6.64
AVG. HEAD ON TOP OF LAYER 2	24.3248		
CHANGE IN WATER STORAGE	1.823	6617.170	5.81
SOIL WATER AT START OF YEAR	29.547	107256.930	
SOIL WATER AT END OF YEAR	27.774	100820.852	
SNOW WATER AT START OF YEAR	0.030	108.900	0.10
SNOW WATER AT END OF YEAR	3.626	13162.146	11.56
ANNUAL WATER BUDGET BALANCE	0.0300	108.921	0.10

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.36	88426.828	100.00
RUNOFF	3.590	13031.458	14.74
EVAPOTRANSPIRATION	20.911	75907.500	85.84
PERC./LEAKAGE THROUGH LAYER 2	2.030549	7370.893	8.34

AVG. HEAD ON TOP OF LAYER 2	22.8664		
CHANGE IN WATER STORAGE	-2.172	-7883.099	-8.91
SOIL WATER AT START OF YEAR	27.774	100820.852	
SOIL WATER AT END OF YEAR	29.229	106099.898	
SNOW WATER AT START OF YEAR	3.626	13162.146	14.88
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.075	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.70	111440.992	100.00
RUNOFF	1.098	3985.049	3.58
EVAPOTRANSPIRATION	27.320	99169.805	88.99
PERC./LEAKAGE THROUGH LAYER 2	2.103708	7636.461	6.85
AVG. HEAD ON TOP OF LAYER 2	24.8163		
CHANGE IN WATER STORAGE	0.179	649.704	0.58
SOIL WATER AT START OF YEAR	29.229	106099.898	
SOIL WATER AT END OF YEAR	29.408	106749.602	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.023	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.44	139537.187	100.00
RUNOFF	3.403	12351.164	8.85
EVAPOTRANSPIRATION	32.952	119615.633	85.72
PERC./LEAKAGE THROUGH LAYER 2	2.096506	7610.316	5.45
AVG. HEAD ON TOP OF LAYER 2	24.7725		
CHANGE IN WATER STORAGE	-0.011	-39.934	-0.03
SOIL WATER AT START OF YEAR	29.408	106749.602	
SOIL WATER AT END OF YEAR	29.346	106526.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.051	183.479	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.91	90423.328	100.00
RUNOFF	3.078	11173.704	12.36
EVAPOTRANSPIRATION	21.074	76498.406	84.60
PERC./LEAKAGE THROUGH LAYER 2	2.024371	7348.466	8.13
AVG. HEAD ON TOP OF LAYER 2	22.6948		
CHANGE IN WATER STORAGE	-1.266	-4597.267	-5.08

SOIL WATER AT START OF YEAR	29.346	106526.187	
SOIL WATER AT END OF YEAR	28.130	102112.406	
SNOW WATER AT START OF YEAR	0.051	183.479	0.20
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.41	143058.250	100.00
RUNOFF	9.500	34483.324	24.10
EVAPOTRANSPIRATION	26.401	95834.016	66.99
PERC./LEAKAGE THROUGH LAYER 2	2.096592	7610.628	5.32
AVG. HEAD ON TOP OF LAYER 2	24.7874		
CHANGE IN WATER STORAGE	1.413	5130.355	3.59
SOIL WATER AT START OF YEAR	28.130	102112.406	
SOIL WATER AT END OF YEAR	29.471	106978.914	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.073	263.842	0.18
ANNUAL WATER BUDGET BALANCE	0.0000	-0.077	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.99	127013.680	100.00
RUNOFF	7.235	26263.727	20.68
EVAPOTRANSPIRATION	25.541	92715.023	73.00
PERC./LEAKAGE THROUGH LAYER 2	2.103220	7634.687	6.01
AVG. HEAD ON TOP OF LAYER 2	24.8063		
CHANGE IN WATER STORAGE	0.110	400.256	0.32
SOIL WATER AT START OF YEAR	29.471	106978.914	
SOIL WATER AT END OF YEAR	29.654	107643.016	
SNOW WATER AT START OF YEAR	0.073	263.842	0.21
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.56	1.42	2.51	3.11	3.62	3.94
	3.78	2.92	3.50	2.24	2.23	2.08
STD. DEVIATIONS	0.64	0.65	1.40	1.67	1.86	2.09
	1.75	1.72	1.68	1.27	1.02	1.00
RUNOFF						
TOTALS	0.562	0.811	1.186	0.283	0.240	0.162
	0.080	0.005	0.154	0.000	0.237	0.370

STD. DEVIATIONS	0.730	0.695	1.185	0.503	0.720	0.590
	0.246	0.018	0.479	0.000	0.515	0.540

EVAPOTRANSPIRATION

TOTALS	0.641	0.797	2.059	3.006	3.456	3.989
	3.672	2.442	2.852	2.005	1.001	0.696
STD. DEVIATIONS	0.112	0.190	0.393	0.694	1.241	1.421
	1.664	1.467	1.076	0.611	0.208	0.134

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	0.1720	0.1513	0.1690	0.1748	0.1817	0.1707
	0.1742	0.1725	0.1715	0.1792	0.1768	0.1821
STD. DEVIATIONS	0.0055	0.0039	0.0079	0.0127	0.0112	0.0077
	0.0085	0.0078	0.0109	0.0089	0.0132	0.0106

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 2

AVERAGES	22.2350	21.1860	21.7047	25.6736	26.0327	24.2275
	23.4735	22.9081	24.4977	25.1644	26.3762	26.1651
STD. DEVIATIONS	1.5105	1.4820	2.7056	4.4890	3.8158	2.7177
	2.8923	2.6641	3.8358	3.0531	4.6742	3.6285

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.89 (5.107)	119401.6	100.00
RUNOFF	4.089 (2.6605)	14843.82	12.432
EVAPOTRANSPIRATION	26.615 (3.5370)	96613.77	80.915

PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	2.07581 (0.06620)	7535.186	6.31079
AVERAGE HEAD ACROSS TOP OF LAYER 2	24.137 (1.917)		
CHANGE IN WATER STORAGE	0.111 (1.1926)	403.37	0.338

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	4.09	14846.700
RUNOFF	1.786	6483.8291
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.006803	24.69497
AVERAGE HEAD ACROSS LAYER 2	36.000	
SNOW WATER	4.36	15834.7090
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3980	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1077	

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	14.2817	0.3967
2	15.3720	0.4270
SNOW WATER	0.000	

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APPENDIX C

COST ESTIMATES

No Further Action

Objective: Determine capital and O&M costs for No Further Action alternative

Cost Summary:

NFA	Capital	$0
	Annual O&M	$218,000
	Present Worth O&M	$3,351,096
	Total Cost	$3,351,096

No Further Action - Cost Backup

O&M Costs Associated with the Existing Cap

Fence repairs and lock replacement - assume $2,500 per year		$2,500
Sign repairs/replacement - assume $300 per year		$300
Mowing - twice per year at $30 per acre		$3,060
Inspection of cover and swales - quarterly @ 8hr * $50/hr		$1,600
Cleaning of drainage features - quarterly @ 32hr * $50/hr		$6,400
Rework of cover soils (assume 5%/yr needs rework to a depth of 2 ft @ $3.50/cu.yd.)		$33,880
Reporting (quarterly)		$28,000
Engineering Oversight/Coordination - assume 15% of total O&M		$11,361
	ANNUAL TOTAL:	$88,000

O&M Costs Associated with Gas Collection & Treatment

Assume $50,000 per year, which is typical for similar systems ANNUAL TOTAL: $50,000

O&M Costs Associated with Leachate Extraction

Assume the same O&M cost as that presented under Alternative LC1

ANNUAL TOTAL: $5,000

O&M Costs Associated with Leachate Extraction

Assume the same O&M cost as that presented under Alternative LT1

ANNUAL TOTAL: $75,000

Combined annual O&M cost = $88,000 + $50,000 + $5,000 + $75,000 = **$218,000**

CAPPING COSTS - SUMMARY

Objective: Determine capital and O&M costs for capping alternatives.

Alternatives:

C1 - *rework existing 807 cover over entire landfill*
C2 - 807 cover over entire landfill
C3 - 811 cover over entire landfill (with supplemental clay and replacement clay options)

Cost Summary:

C1	Capital Costs		$1,475,000
	Annual O&M:	$88,000	
	Present Worth (5%, 30 years)		$1,360,000
		TOTAL:	$2,835,000
C2	Capital Costs		$5,252,000
	Pre-design investigation		$146,880
	Annual O&M:	$88,000	
	Present Worth (5%, 30 years)		$1,352,736
		TOTAL:	$6,610,000
C3	Supplemental Clay Option Capital Costs		$7,498,000
	Replacement Clay Option Capital Costs		$9,886,000
	Annual O&M:	$88,000	
	Present Worth O&M (same as C2)		$1,352,736
		TOTAL (using supplemental clay):	$8,860,000
		TOTAL (using replacement clay):	$11,240,000

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CAPPING COSTS

C1 Capital Costs:

Assume under the no action alternative that only the top three feet of cover soils will be regraded and that new vegetetation will be established.

Mobilization/Demobilization		$15,000
Site Safety Plan		$10,000
Clear/Grub	(assume 51 acres @ $1,500 per acre)	$76,500
Purchase & install existing well/piezometer protection	(assume $500 per well * 75 wells)	$37,500
Regrading (working 3' soils)	(246,840 cu.yd.*$3.50 per cu.yd.)	$863,940
Establish vegetation	(51 acres @ $1,500 per acre)	$76,500
Installation of temporary fencing, riprap, temporary access roads, etc.		$100,000
Engineering (10% of capital costs)		$117,944
Estimating Contingency (material delays, weather, etc., assume 15% of total capital)		$176,916
	TOTAL:	$1,475,000

C1 O&M Costs:

Fence repairs and lock replacement - assume $2,500 per year		$2,500
Sign repairs/replacement - assume $300 per year		$300
Mowing - twice per year @ $30/acre		$3,060
Inspection of cover and swales	quarterly @ 8/hr * $50/hour	$1,600
Cleaning of drainage features	quarterly @ 32/hr * $50/hour	$6,400
Rework of cover soils (assume 5%/year needs rework, 3 acres/year @ $3.50/cubic yard assume 2' depth)		$33,880
Reporting (quarterly)		$28,000
Engineering Oversight/Coordination - assume 15% of total O&M)		$11,361
	TOTAL O&M/YR:	$88,000

CAPPING COSTS

C2 Capital Costs:

Mobilization/Demobilization		$50,000
Site Safety Plan		$50,000
Clear/Grub	51 acres @ $1,500/acre	$76,500
Purchase & install existing well/piezometer protection	$500/well * 75 wells	$37,500
Regrading (working 2' soils)	164,560 cu.yd. * $5/cubic yard	$575,960
Place/compact 2' soils	51 acres @ 2' * $10/cubic yard	$1,645,600
Grading 2' cover soils	164,560 cubic yards * $5/cu.yd.	$822,800
Establish vegetation	51 acres @ $1,500/acre	$76,500
Implementation of drainage systems, erosion controls		$350,000
Installation of temporary fencing, riprap, temporary access roads, etc.		$205,000
Clay testing and documentation (20% of capital costs)		$777,972
Engineering (15% of capital costs)		$583,479
Estimating Contingency (material delays, weather, etc., assume 20% of total capital)		$767,972
	TOTAL:	$5,252,000

C2 Pre-Design Investigation

Wetlands pre-construction delineation & marking		$75,000
Geotech. borings: 4 per A*51A* 1d/30 borings*$2,500/d+$100/ana.*204 ana.+$10,000 oversgt.		$47,400
Estimating Contingency (weather, etc., assume 20% of total capital)		$24,480
	TOTAL:	$146,880
	TOTAL CAPITAL:	$5,398,880

C2 O&M

Fence repairs and lock replacement - assume $2,500 per year		$2,500
Sign repairs/replacement - assume $300 per year		$300
Mowing - twice per year @ $30/acre		$3,060
Inspection of cover and swales	quarterly @ 8/hr * $50/hour	$1,600
Cleaning of drainage features	quarterly @ 32/hr * $50/hour	$6,400
Rework of cover soils (assume 5%/year needs rework, 3 acres/year @ $3.50/cubic yard assume 2' depth)		$33,880
Reporting (quarterly)	$7,000/quarter	$28,000
Engineering Oversight/Coordination - assume 15% of total O&M)		$11,361
	TOTAL O&M/YR:	$88,000

C3 Capital Costs

Low Range Estimate: Assumes enough clay is recoverable to construct 811 cap with some off-site clay. (Refer to attached calculations.)

Same capital cost as C2 with the following additional costs:	$5,398,880
Purchase, place, compact 105,000 cu.yd of clay @ $12/cu.yd.	$1,260,000
Borrow Study (assume 25% of purchase, place, compact price)	$315,000
Additional Mobe/Demobe costs, attributable to moving materials from off-site	$250,000
Estimating Contingency (material delays, weather, etc., assume 15% of add. capital)	$273,750
TOTAL CAPITAL, LOW RANGE ESTIMATE:	$7,498,000

High Range Estimate: Assumes 250,000 cu.yd. of new clay must be brought in from an off-site source.

Same as C3 low except purchase of 250,000 cu.yd. of clay & 2X mobe/demobe costs - 2 seasons	$9,886,000
TOTAL CAPITAL, HIGH RANGE ESTIMATE:	$9,886,000

C3 O&M

Same as C2:	TOTAL O&M/YR:	$88,000

***Estimation of amount of additional clay and cover soil needed to create 811 cap (for Alternative C3)**

Given

Old Landfill:	24 acres, 6" to 14" clay	avg. =	10"
New Landfill:	27 acres 25" to 63" clay	avg. =	44"
Total (both):	51 acres, 49" to 87" clay and cover material	avg. =	68"

Total Cap - Clay = Cover Soil

Cover Soils Needed to Create 811 Cap

Old Landfill: (24A) (43,560 sq.ft./A) [68 ft/12 - 10 ft/12]/27
= 187,150 cu.yd.

New Landfill: (27A)(43,560 sq.ft./A) [68 ft/12 - 44 ft/12 ft]/27
= 87,120 cu.yd.

Total Cover Soils = 274,270 cu.yd.

Cover Soils Needed: (51A)(43,560 sq.ft./A) (3 ft)/27
= 246,840 cu.yd.

Surplus Cover Soil = 27,430 cu.yd.

No additional cover material needed

Clay Needed to Create 811 Cap

Total Existing Clay = (24A) (43,560 sq.ft./A) (10 ft/12)/27 +
(27A) (43,560 sq.ft./A)(44 ft/12)/27

= 191,990 cu.yd.

*Assume only 75% of existing clay is reuseable for construction of new cap:

Total Available Clay = 143,993 cu.yd.

Additional Clay Needed = 246,840 cu.yd. - 143,993 cu.yd.

= 102,850 cu.yd.

CAPPING TIMING

C1: *Assume 6,000 cubic yards/day can be moved, 6-day work week
*Assume only the top 3 feet of soil will be reworked

Top 3 feet = 246,840 cubic yards

$Time_{c1}$ = (246,840 cubic yards)/6,000 cubic yards/day = 42 days

Allow 25% for contingencies such as rain, equip. delays, etc. = $\boxed{\text{52.5 days, 9 weeks}}$

C2: *Assume 6,000 cubic yards/day can be moved, 6-day work week

Total cover soils	=	274,270 cubic yards
Total clay	=	191,990 cubic yards
Total cap	=	466,260 cubic yards

$Time_{c2}$ = (466,260 cubic yards)/6,000 cubic yards/day = 78 days

Allow 25% for contingencies such as rain, equip. delays, etc. = $\boxed{\text{97.5 days, 17 weeks}}$

C3: Supplemental Clay Option -
Same as C2 with addition of an extra 102,850 cu.yd. of clay

87 days + (102,850 cubic yards/6,000 cubic yards/day) = 105 days

Allow 25% for contingencies such as rain, equip. delays, etc. = $\boxed{\text{131.25 days, 22 weeks}}$

C3: New Off-Site Clay Option -
Same as C2 with addition of an extra 250,000 cu.yd. of clay

87 days + (250,000 cubic yards/6,000 cubic yards/day) = 129 days

Allow 25% for contingencies such as rain, equip. delays, etc. = $\boxed{\text{161.25 days, 27 weeks}}$

If the new off-site clay option is selected, cap construction will take more than one construction season.

Gas Alternatives

Objective: Determine capital and O&M costs for gas extraction/treatment alternatives

Alternatives:

G1 - No Action, utilize existing system

G2 - Combination of existing and new systems:

* Use existing stick flares without any upgrades
* Construct a new active system for the Old Landfill consisting of 5 new wells (in addition to the existing piezometers/vents) piping, blower/flare

G3 - Enhanced extraction system:

* Convert 14 existing stick flares to wells and use 14 existing leachate/gas wells
* Construct 6 new wells
* Construct header piping, driplegs, condensate piping, blower, and flare

Cost Summary:

G1	Capital	$227,500
	Annual O&M	$50,000
	Present Worth O&M	$768,600
	Total Cost	$996,100
G2	Capital	$714,155
	Annual O&M	$35,000
	Present Worth O&M	$538,020
	Total Cost	$1,252,175
G3	Capital	$910,000
	Annual O&M	$50,000
	Present Worth O&M	$768,600
	Total Cost	$1,678,600

Gas Alternatives - Cost Backup

G1 - No Action

Capital Costs

* Assume 25% of the G3 capital cost for repair as needed.

O&M Costs

* Assume $50,000/yr, which is typical for similar systems.

Use a 30 yr timeframe to calculate present worth for O&M:
$50,000 * 15.372 (5%,30 yrs) = $768,600

G2 - Combination of existing and new systems

Capital Costs

Costs for G3 can be used except for a reduction to items as marked by "*" on the calculation spreadsheet (which total $445,800)

For this alternative, to remain conservative, use half of those costs:
$910,055 - 0.5($21,000+$287,500+$17,000+$20,400+$60,000+$8,400+$31,500) = $714,155

O&M Costs

O&M on the active portion of the site would be approximately 0.5 * $50,000 = $25,000.
Maintenance on the existing gas flares may be $10,000: $35,000/yr

Use a 30 yr timeframe to calculate present worth for O&M: $538,020

G3 - Enhanced extraction system

Capital Costs

See attached spreadsheet.

O&M Costs

* Assume $50,000/yr, which is typical for similar systems.

Use a 30 yr timeframe to calculate present worth for O&M:
$50,000 * 15.372 (5%,30 yrs) = $768,600

GAS COLLECTION SYSTEM
H.O.D. Landfill

CAPITAL CONSTRUCTION COST ESTIMATE

Item	Type of Work	Estimated Quantities	Unit	Unit Price	Extended Price
1.	Mobilization/Demobilization	1	LS	$50,000.00	$50,000.00
2.	Site Safety Plan	1	LS	$7,500.00	$7,500.00
3.	Gas Wells*	210	LF	$100.00	$21,000.00
4.	Gas Pipe Trenches*	11,500	LF	$25.00	$287,500.00
5.	*Header Riser/Cleanouts**	34	EACH	$500.00	$17,000.00
6.	Gas Wellheads*	34	EACH	$600.00	$20,400.00
7.	Knock-Out/Lift Station (KO/LS)*	3	LS	$20,000.00	$60,000.00
8.	Individual Control Wires (To KO/LSs)*	4,200	LF	$2.00	$8,400.00
9.	Condensate Pressure Conveyance Pipe*	4,200	LF	$7.50	$31,500.00
10.	Dripleg	1	EACH	$6,000.00	$6,000.00
11.	Condensate Holding Tank	1	LS	$25,000.00	$25,000.00
12.	Compressor and Control Station	1	LS	$40,000.00	$40,000.00
13.	Blower Station	1	LS	$40,000.00	$40,000.00
14.	Utility Flare Station	1	LS	$40,000.00	$40,000.00
15.	Clear and Grub	0.62	acres	$1,200.00	$744.00
16.	Access Road	3000	SY	$5.00	$15,000.00
17.	Chainlink Fencing	300	LF	$10.00	$3,000.00
18.	Electrical Service Supply	1	LS	$15,000.00	$15,000.00
TOTAL Extended Capital Construction Price					**$688,044.00**

ADDITIONAL CONSULTING SERVICES

Item	Type of Work	Estimated Quantities	Unit	Unit Price	Extended Price
1.	Annual Reporting	1	LS	$50,000.00	$50,000.00
2.	Bid-Phase Assistance	5% of Cap. Cost	LS	$34,402.20	$34,402.20
3.	Construction Management	10% of Cap. Cost	LS	$68,804.40	$68,804.40
4.	Engineering	10% of Cap. Cost	LS	$68,804.40	$68,804.40
TOTAL Additional Consulting Services Price					**$222,011.00**
TOTAL Extended Price					**$910,055.00**

* Refer to backup calculations. The costs for these items are lower for Alternative G2.

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Mad J:1252/035/03/cost1-1297_revised
2/6/98
1252035.031801

Leachate Extraction

Objective: Determine capital and O&M costs for alternatives for leachate extraction

Alternatives:

LC1 - No action, utilize existing manholes/piping
LC2 - Existing wells plus new collection piping
LC3 - Combination, New LF = Alt. LC2, Old LF = Alt. LC3
LC4 - Dual extraction

Cost Summary:

LC1	Capital Costs	$0
	Annual O&M	$ 5,000
	Present Worth O&M	$ 76,860
	Total	$76,860
LC2	Capital Costs	$227,800
	Annual O&M	$ 60,000
	Present Worth O&M	$ 922,320
	Total	$ 1,150,120
LC3	Capital Costs	$ 345,545
	Annual O&M	$ 72,000
	Present Worth O&M	$ 1,107,000
	Total	$ 1,452,545
LC4	Capital Costs	$ 403,490
	Annual O&M	$ 60,000
	Present Worth O&M	$ 922,320
	Total	$ 1,325,810

Leachate Extraction

LC1 - No action

Capital Costs

Assume negligible capital cost, $0

O&M Costs

*Assume 4 times per year check MH/pipes, clean pipes annually
$2,000 for cleaning & 32 hours @ $60/hr = $ 3,920 (Say $5,000/yr.)

Present worth cost of O&M (5%, 30 yrs) = $ 76,860

LC2 - Existing wells plus new collection piping

Capital Costs

Assume capping work will occur so removal of clay to place pipe is negligible.

Addition of a 5,000 gallon storage tank is needed for temporary leachate storage =		$ 25,000
Automation of collection system, assume $30,000		$ 30,000
Pipe trenches, pipe, and backfill, approximately 4,200 ft of pipe @ $35/ft =		$147,000
Engineering/Construction Management (15% of cap. costs) =		$ 25,800
	Total	$227,800

O&M Costs

Assume $60,000/year due to added pumping requirements.

LC3 - Combination, New LF = Toe drain, existing wells, Old LF = Dual extraction

Capital Costs

New LF: Use LC2 - 2,400' of pipe @ $35/ft =	$143,800
Old LF: Use details for LC4, assume 1/2 LC4 =	$201,745
Total Capital Cost =	$345,545

O&M Costs

Assume, conservatively, sum of 60% of LC2 & LC4 O&M: $72,000/yr, p.w.= $1,107,000

LC4 - Dual extraction wells

Capital Costs

See attached spreadsheet. Total cost = $1,313,490 for dual system; however, this is for both leachate and gas. The additional cost for leachate over and above that needed for gas is $403,490 (Gas cost, assuming Alternative G3 is selected = $910,000).

O&M Costs

Assume O&M costs of $60,000 per year, based on previous experience.
Present worth of O&M = $60,000 (5%, 30 yrs) = $922,320

DUAL EXTRACTION SYSTEM
H.O.D. LANDFILL

CAPITAL CONSTRUCTION COST ESTIMATE

Item	Type of Work	Estimated Quantities	Unit	Unit Price	Extended Price
1.	Mobilization/Demobilization	1	LS	$50,000.00	$50,000.00
2.	Site Safety Plan	1	LS	$7,500.00	$7,500.00
3.	Gas Wells	210	LF	$100.00	$21,000.00
4.	Gas Pipe Trenches	11,500	LF	$25.00	$287,500.00
5.	Leachate Gravity Conveyance Pipe	11,500	LF	$5.00	$57,500.00
6.	Header Riser/Cleanouts	34	EACH	$500.00	$17,000.00
7.	Gas/Leachate Wellheads	34	EACH	$600.00	$20,400.00
8.	Well Pumps w/ Transmitter /Controls	34	EACH	$3,500.00	$119,000.00
9.	Knock-Out/Lift Station (KO/LS)	3	LS	$20,000.00	$60,000.00
10.	Individual Control Wires (To KO/LSs)	4,200	LF	$2.00	$8,400.00
11.	Leachate Pressure Conveyance Pipe	4,200	LF	$7.50	$31,500.00
12.	Dripleg	1	EACH	$6,000.00	$6,000.00
13.	Condensate/Leachate Holding Tank	1	LS	$25,000.00	$25,000.00
14.	Compressor and Control Station	1	LS	$40,000.00	$40,000.00
15.	Blower Station	1	LS	$40,000.00	$40,000.00
16.	Utility Flare Station	1	LS	$40,000.00	$40,000.00
17.	Clear and Grub	0.62	acres	$1,200.00	$743.80
18.	Access Road	3000	SY	$5.00	$15,000.00
19.	Chainlink Fencing	300	LF	$25.00	$7,500.00
20.	Electrical Service Supply	300	LS	$15,000.00	$15,000.00
21.	System Automation	15% of Cap. Cost	LS	$15,000.00	$102,870.00
	TOTAL Extended Capital Construction Price				**$971,913.80**

ADDITIONAL CONSULTING SERVICES

Item	Type of Work	Estimated Quantities	Unit	Unit Price	Extended Price
1.	Annual Reporting	1	LS	$50,000.00	$50,000.00
2.	Bid-Phase Assistance	10% of Cap. Cost	LS	$97,191.38	$97,191.38
3.	Construction Management	10% of Cap. Cost	LS	$97,191.38	$97,191.38
4.	Engineering	10% of Cap. Cost	LS	$97,191.38	$97,191.38
	TOTAL Extended Capital Construction Price				**$341,574.14**
	TOTAL Extended Price				**$1,313,487.94**

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2/6/98
1252035.031801

Leachate Treatment Alternatives

Objective: Identify and estimate costs of leachate management approaches.

General Assumptions

* Future flow rate of 30 gpm
* Leachate quality will correspond to that identified in the RI

LT1: No action

* Baseline, lowest cost option
* Existing cost from Waste Management

LT2: Pretreat and discharge to POTW

* Primary objectives are to reduce copper and BOD levels
* Metals pretreatment options include chemical and physical (e.g., precipitation and clarification, ion exchange, oxidation, reverse osmosis)
* Assume BOD limit is based on carbonaceous demand (i.e., nitrogenous demand is inhibited, so exclude ammonia)

Recommendation:

Remove metals by lime or caustic precipitation and clarification, lower BOD by air stripping, press sludge.

Key Assumptions:

*Costs do not include costs associated with baseline (e.g. hauling treated water to POTW, subsequent disposal at POTW, extraction costs)

LT3: Treatment and surface discharge

* Objective is to meet NPDES discharge limits
* Assumes appropriate discharge location exists
* Reverse osmosis would treat all compounds listed in Table 3-1 and is the worst case cost.

Key Assumption:

* Does not include baseline costs
* Assumes surface water source is available/acceptable.

Flip to Portrait, like all the others

Leachate Treatment

Objective: Determine capital and O&M costs for treatment alternatives

Alternatives:

LT1 - No Further Action
LT2 - Pretreat and discharge to POTW
LT3 - Treat and surface discharge

Cost Summary:

LT1	Capital		$0
	Annual O&M		$ 75,000
	Present Worth O&M		$ 1,152,900
	Total Cost		$ 1,152,900
LT2	Capital		$ 489,000
	Annual O&M		$ 588,000
	Present Worth O&M		$ 9,038,736
	Total Cost		$ 9,527,736
		Low Range	High Range
LT3	Capital	$ 1,363,000	$ 1,912,000
	Annual O&M	$ 550,000	$ 635,000
	Present Worth O&M	$ 8,454,600	$ 9,761,220
	Total Cost	$ 9,817,600	$ 11,673,220

LT1 - No Action: Pump, Transport, & Dispose at Remote POTW

Assume the total cost of pumping leachate from the existing manholes and wells is approximately equal to the present worth of transport/discharge costs for 30 years.

Assume that the current extraction rate is 1 gpm and that the cost for transport using a 5,000 gallon tanker truck and discharge to the POTW combined is $0.07/gallon.

Calculate Present Worth of this option over 30 years:

P.W. = (1 gal/min) * (60 min/hr) * (24 hr/day) * (365 day/yr) * $0.07/gal * 15.372 =

P.W. = $565,600

Assume a 35% contingency factor to allow for replacement materials, repairs, etc.:

P.W. = $763,600

Assume the annual operation and maintenance cost for this option is approximately $75,000 per year.

O&M P.W. = $1,152,900

LT2 - Pretreat and discharge to POTW: Cost Backup Calculations

I. Implementation

A. Consulting

1. Design

80 hrs * $74/hr =	$	5,920
12 hrs * $92/hr =	$	1,104
24 hrs * $78/hr =	$	1,872
4 hrs * $106/hr =	$	424
24 hrs * $44/hr =	$	1,056
	$	10,376

2. Building Permit

8 hrs * $74/hr =	$	592
2 hrs * $92/hr =	$	184
1 hr * $106/hr =	$	106
2 hrs * $44/hr =	$	88
	$	970

3. Preconstruction

a. Subcontractor Procurement

40 hrs * $78/hr =		3,120
4 hrs * $92/hr =		368
2 hrs * $106/hr =		212
8 hrs * $44/hr =		352
	$	4,052

b. Meetings

8 hrs * $78/hr =	$	624
4 hrs * $92/hr =	$	368
4 hrs * $44/hr =	$	176
	$	1,168

c. Health & Safety Plan

8 hrs * $74/hr =	$	592
1 hr * $92/hr =	$	92
4 hrs * $44/hr =	$	176
	$	860

4. Oversight - assume 15 days

15 hrs * $78/hr =	$	1,170
+25% office =	$	293
+ mileage =	$	100
	$	1,563

5. Startup - assume 5 days

10 hrs * $62/hr =	$	620
+25% office =	$	155
+ mileage =	$	100
	$	875

6. Project Closeout

a. O&M Plan

20 hrs * $74/hr =	$	1,480
4 hrs * $92/hr =	$	368
2 hrs * $106/hr =	$	212
8 hrs * $44/hr =	$	352
	$	2,412

b. Documentation

* Same as O&M =	$	2,412
+ 24 hrs * $74/hr =	$	1,776
	$	4,188

7. Project Management

* Assume %15 of other consulting costs

B. Commodity

1. Mobilization

*Assume $ 1,500

2. Building - assume 30' x 30'

a. Slab

30' x 30' x 3/4' = 25 cu.yd. concrete

25 cu.yd. * $150/cu.yd. = $ 3,750 (includes rebar & finish)

b. Building

*Assume $ 35,000

3. Mechanical

a. Holding Tank (influent & effluent)

Provide storage for 3 days @ 30 gpm = 129,600 gallons

129,600 gallons * $0.6/gal for steel = $ 77,760 each

b. Transfer Pumps - One each for influent holding tank and effluent holding tank

*Assume $ 2,500 each

c. Clarifier Package - includes rapid mix, floc and settling chambers, floc and flash mixers, sludge pumps and controls: $ 23,000

(Cost is per Graver Water (page 8).)

d. Air Stripper - $ 27,000 per past experience

e. Contact Tank - for sulfuric @ 5 min. residence time
30 gpm * 5 min = 150 gal
*Assume $ 500

f. Metering Pump - one each for caustic, polymer, sulfuric.
*Assume $ 1,200 each

g. Filter Press
*Assume $ 10,000

h. Sludge Holding Tank
*Assume 1,000 gal ~ $ 1,500

i-k. Assumed costs

4. Electrical - Assumed costs

II. Annual O&M

A. Consulting

1. Operating Labor - Assume 8 hrs/wk * 52 wks = 416 hrs

2. Maintenance Labor - Assume 8 hrs/mo.* 12 mo. = 96 hrs

3. Maintenance Materials - Assume 5% of mechanical & electrical equipment cost

4. Effluent Monitoring - Assume monthly influent & effluent sampling - 1hr labor

5. Quarterly Reporting to POTW

8 hrs * $74/hr =	$	592
1 hr * $92/hr =	$	92
1 hr * $106/hr =	$	106
2 hr * $44/hr =	$	88
	$	878

6. Project Management
* Assume %15 of other consulting costs

B. Commodity

1. Electrical
Approx. 2, 0.5 hp transfer pumps, 7.5 hp air stripper blowers
8.5 hp * 0.746 kW/hp * 24 hr/d *365d/yr = 55,550 kW-hr

2. Analytical
* Assume monthly BOD and metals @ $250/round

3. Caustic, polymer, sulfuric - assume $5,000/yr.

4. Sludge Disposal - Assume sludge equals 2% of annual volume treated, 315,000gal * $0.40/gal, $126,000 for each of first 5 years

$22,150 for each year after 5th

Present worth of sludge disposal = (5%, 5 yrs@30pm, 25 yrs@5.25gpm)	$790,116
Annualized cost of sludge disposal =	$51,400

5. Discharge to POTW - Assume $0.06 per gallon.

First 5 years (15,407,000 gal@0.06$/gal):	$924,420
Each year after the fifth (2,769,550 gal@$0.06/gal):	$166,173
Present worth of discharge = (5%, 5 yrs@30pm, 25 yrs@5.25gpm)	$5,837,299
Annualized cost of discharge =	$379,800

TABLE 1

PROJECT: H.O.D. Leachate Management	PROJECT NO.: 1252035.031801
	DATE: 6-Feb-98
PRELIMINARY COST ESTIMATE	

OPTION: Pretreatment and POTW Discharge

DESCRIPTION	QTY	UNIT	UNIT COST	EXTENDED COST
I. INITIAL IMPLEMENTATION ESTIMATED COSTS				
A. Consulting Services				
1. System Design (Drawings/Specs)	1	LS	$10,500	$10,500
2. Permitting (Building)	1	LS	$1,000	$1,000
3. Preconstruction				
a. Subcontractor procurement	1	LS	$4,100	$4,100
b. Construction coordination and preconstruction meeting	1	LS	$1,200	$1,200
c. Site safety plan	1	LS	$900	$900
4. Construction Oversight	15	DAYS	$1,600	$24,000
5. System Start-up	5	DAYS	$875	$4,375
6. Project Closeout				
a. O&M and long-term monitoring plan	1	LS	$2,450	$2,450
b. Construction documentation report	1	LS	$4,300	$4,300
7. Project Management/Meetings	1	LS	$8,800	$8,800
Subtotal				$61,625
Estimating Contingency (20%)				$12,325
Total Consulting Services Initial Implementation Estimated Cost				$74,000
B. Commodity Services				
1. Mobilization/Demobilization	1	LS	$50,000	$50,000
2. Remediation Building				
a. Concrete foundation	25	CY	$150	$3,750
b. Building	1	EA	$35,000	$35,000
3. Mechanical Work				
a. Holding tank	2	EA	$78,000	$156,000
b. Transfer pump	2	EA	$2,500	$5,000
c. Lamella clarifier, mixers, sludge pumps	1	LS	$23,000	$23,000
d. Diffused air stripper, blower	1	EA	$27,000	$27,000
e. Contact tank	1	EA	$500	$500
f. Metering pump	3	EA	$1,200	$3,600
g. Filter press	1	EA	$10,000	$10,000
h. Sludge holding tank	1	EA	$1,500	$1,500
i. Piping within remediation building	1	LS	$6,000	$6,000
j. Gauges, valves, fittings, sample ports	1	LS	$4,000	$4,000
k. Exhaust fan and louver in treatment building	1	EA	$1,000	$1,000
4. Electrical Work				
a. Lights, switches, and outlets	1	LS	$2,000	$2,000
b. Controls and control panel	1	LS	$8,000	$8,000
c. Electric heater and thermostat	1	EA	$1,500	$1,500
d. Distribution panel, wiring, and conduit	1	LS	$3,000	$3,000
e. Electric meter and utility service to building	1	LS	$5,000	$5,000

Subtotal	$345,850
Estimating Contingency (20%)	$69,170
Total Commodity Services Initial Implementation Estimated Cost	$415,000
TOTAL INITIAL IMPLEMENTATION ESTIMATED COST	**$489,000**

TABLE 1 (cont.)

DESCRIPTION	QTY	UNIT	UNIT COST	EXTENDED COST
II. ANNUAL O&M ESTIMATED COSTS				
A. Consulting Services				
1. Operation Labor	416	HRS	$60	$24,960
2. Maintenance Labor	96	HRS	$60	$5,760
3. Maintenance Materials	1	LS	$5,055	$5,055
4. Effluent monitoring	12	HRS	$60	$720
5. Reporting to POTW	4	RPT	$900	$3,600
6. Project Management/Meetings	1	LS	$6,200	$6,200
Subtotal				$46,295
EstimatingContingency (20%)				$9,259
Total Consulting Services Annual O&M Estimated Cost				$56,000
B. Commodity Services				
1. Electrical Power	55,550	Kw-Hrs	$0.08	$4,444
2. Effluent Monitoring Laboratory Analyses	12	EA	$250	$3,000
3. Caustic, polymer, and sulfuric	1	LS	$5,000	$5,000
4. Sludge Disposal	*	gal	$0.40	$51,400
5. Discharge to POTW	*	gal	$0.06	$379,800
Subtotal				$443,644
Estimating Contingency (20%)				$88,729
Total Commodity Services Annual O&M Estimated Cost				$532,000
TOTAL ANNUAL O&M ESTIMATED COST				**$588,000**

General Notes:

1. Initial implementation and annual O&M estimated costs shown are approximate and for comparison only.
2. Operation labor is based on an average of 8 hours of operating labor required every week.
3. Maintenance labor is based on an average of 8 hours of maintenance labor required every month.
4. Maintenance materials estimate is based on 5% of the electrical and mechanical equipment initial implementation costs
5. Electrical power usage is based on one 5 hp blower and two 0.5 hp transfer pumps operating continuously and miscellaneous electrica equipment - lights, heat, etc.

* Refer to backup calculations. Sludge disposal and discharge amounts decrease significantly after the first five years of operation.

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LT3 - Treatment and surface discharge: Cost Backup Calculations

I. Implementation

A. Consulting

Same as LT2, except cost of system design and building permitting increase, add NPDES permit:

80 hrs * $74/hr =	$ 5,920
80 hrs * $92/hr =	$ 7,360
60 hrs * $54/hr =	$ 3,240
40 hrs * $106/hr =	$ 4,240
	$ 21,000

B. Commodity

3. Mechanical
a. Holding tank - only need one - continuous discharge.

c. Reverse Osmosis Units - $500,000 capital per ROCHEM.
Includes enclosure, units, pretreat, controls. (page 9)

e. Concentrate holding tank - assume 5,000 gal to allow 1-tank truck disposal, ~ $4,500

II. Annual O&M

A. Consulting

1. Assume 4 hrs/day for labor.

3. Reporting to IEPA - monthly discharge report.

4 hrs * $74/hr =	$ 296
1 hr * $92/hr =	$ 92
1 hr * $106/hr =	$ 106
2 hrs * $44/hr =	$ 88
	$ 600

B. Commodity

1. Electrical/Membranes/Chemicals = $0.05/gal - per ROCHEM.

2. Monitoring - assume VOC/SVOC/BOD/Metals
*Assume $800/event, monthly

3. Sludge Disposal - assume same as option 2 - $51,400/yr

Treatment and surface discharge: Sequencing Batch Reactor

I. Implementation (as for Reverse Osmosis) $159,000
Commodity Services (per telephone conversations) $200,000 & $120,000 + LT2 Pipeline costs
II. Annual O&M - assume less than reverse osmosis, $550,000/yr.

TABLE 2

PROJECT: H.O.D. Leachate Management	PROJECT NO.: 1252035.031801
	DATE: 6-Feb-98
PRELIMINARY COST ESTIMATE	

OPTION: Treat and NPDES Discharge

DESCRIPTION	QTY	UNIT	UNIT COST	EXTENDED COST
I. INITIAL IMPLEMENTATION ESTIMATED COSTS				
A. Consulting Services				
1. System Design	1	LS	$50,000	$50,000
2. Permitting				
a. Building	1	LS	$5,000	$5,000
b. NPDES	1	LS	$21,000	$21,000
3. Preconstruction				
a. Subcontractor procurement	1	LS	$4,100	$4,100
b. Construction coordination and preconstruction meeting	1	LS	$1,200	$1,200
c. Site safety plan	1	LS	$7,500	$7,500
4. Construction Oversight	15	DAYS	$1,600	$24,000
5. System Start-up	5	DAYS	$875	$4,375
6. Project Closeout				
a. O&M and long-term monitoring plan	1	LS	$2,450	$2,450
b. Construction documentation report	1	LS	$4,300	$4,300
7. Project Management/Meetings	1	LS	$8,800	$8,800
Subtotal				$132,725
Estimating Contingency (20%)				$26,545
Total Consulting Services Initial Implementation Estimated Cost				$159,000
B. Commodity Services				
1. Mobilization/Demobilization	1	LS	$50,000	$50,000
2. Remediation Building Foundation	10	CY	$150	$1,500
3. Mechanical Work				
a. Holding tank	1	EA	$78,000	$78,000
b. Transfer pump	2	EA	$2,500	$5,000
c. Reverse osmosis package system	1	LS	$500,000	$500,000
d. Transfer tank	1	EA	$500	$500
e. Concentrate holding tank	1	EA	$4,500	$4,500
f. Piping to remediation building	1	LS	$2,000	$2,000
g. Gauges, valves, fittings, sample ports	1	LS	$2,000	$2,000
4. Electrical Work				
a. Controls and control panel	1	LS	$4,000	$4,000
b. Distribution panel, wiring, and conduit	1	LS	$3,000	$3,000
c. Electric meter and utility service to building	1	LS	$5,000	$5,000
5. Installation of 2-Mile Pipeline to Discharge Point				
Trenching	10,600	LF	$30	$318,000
Piping	10,600	LF	$20	$212,000
Costs associated w/ crossing roads, easements	1	LS	$275,000	$275,000
Subtotal				$1,460,500
Estimating Contingency (20%)				$292,100
Total Commodity Services Initial Implementation Estimated Cost				$1,753,000
TOTAL INITIAL IMPLEMENTATION ESTIMATED COST				**$1,912,000**

TABLE 2 (cont.)

DESCRIPTION	QTY	UNIT	UNIT COST	EXTENDED COST
II. ANNUAL O&M ESTIMATED COSTS				
A. Consulting Services				
1. Operation & Maintenance Labor	1,560	HRS	$60	$93,600
2. Effluent monitoring	12	HRS	$60	$720
3. Reporting to IEPA	12	RPT	$600	$7,200
4. Project Management/Meetings	1	LS	$15,228	$15,228
Subtotal				$116,748
EstimatingContingency (20%)				$23,350
Total Consulting Services Annual O&M Estimated Cost				$140,000
B. Commodity Services				
1. Electrical Power/Membranes/Cleaning Agents/etc.	4,876	KGal	$50	$243,790
2. Effluent Monitoring Laboratory Analyses	12	EA	$800	$9,600
3. Sludge Disposal	*	gal	$0.40	$51,400
4. Effluent conveyance/transport	5,400	KGal	$20	$108,000
Subtotal				$412,790
Estimating Contingency (20%)				$82,558
Total Commodity Services Annual O&M Estimated Cost				$495,000
TOTAL ANNUAL O&M ESTIMATED COST				**$635,000**

General Notes:

1. Initial implementation and annual O&M estimated costs shown are approximate and for comparison only.
2. Operation labor is based on an average of 8 hours of operating labor required every week.
3. Maintenance labor is based on an average of 2 hours of maintenance labor required every week.
4. Electrical power usage, cleaning agents, membrane replacement costs per Rochem Separation Systems.
5. Effluent transport amount is an average value over thirty years.

* Sludge disposal amount varies after five years. Refer to the LT2 backup calculations for further details.

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LEACHATE TREATMENT VOLUME / EXTRACTION RATE FOR ALTERNATIVES LT2 AND LT3.

<u>Leachate maintenance level</u> (as described in RI) = 2 ft below the water level elevation contemporaneously measured in G11D.

Average elevation of G11D (6/93 to 4/94) = (760.68 + 760.01 + 760.68 + 760.48 + 760.53 + 760.96) / 6
= 760.56 ft

* Leachate Maintenance Level =	758.57 ft

Average leachate elevation (as of 4/25/94) = (766.7 + 769.3 + 764.53 + 772.15 + 760.82 + 779.37 + 774.72 + 754.26 + 764.07 + 767.02 + 770.54 + 764.68 + 766.01 + 764.66) / 14

= $\boxed{767.06 \text{ ft}}$

* Historically, leachate elevations have remained fairly constant; therefore, assume the average leachate elevation as as of 4/94 is still representative. Let the amount of leachate to be removed at 30 gpm equal that necessary to achieve the"leachate maintenance level." Let any further extraction be at a rate that is high enough to account for annual infiltration. Based on HELP model results, assume 2 in/yr as a worst-case infiltration estimate. Assume refuse porosity = 0.45.

Amount of leachate to be removed at 15 gpm, V_{15}
(Before accounting for additional infiltration:)

V_{15} = (767.06 ft - 758.57 ft) x (51 acres) x (43,560 sq ft/acre) x (7.48 gal/cu ft) x 0.45

V_{15} =	63.5 MG

Amount of annual leachate production (assume 100% from infiltration, ignore storativity by cap and all other losses for worst case), VLP

V_{LP} = (2/12 ft) x (51 acres) x (43,560 sq ft/acre) x (7.48 gal/cu ft)

V_{LP} =	2,769,545 gal

<u>Time to reach leachate maintenance level, t_{30}</u> (yrs)

t_{30} = (63.5 x 10^6 gal+ 2,769,545 gal/yr x t30) x (1 yr / 7.884 x 10^6 gal)

$t_{30} = 8.054 + 0.351 t_{30}$

t_{30} =	12.4 yrs = 12 yrs, 5 mo.

* Actual volume that will be discharged up to t_{30}:

$$Vt_{30} = 63.5 \times 10^6 + 2{,}769{,}545 \text{ gal/yr} \times 12.4 \text{ yr}$$

$$\boxed{Vt_{30} = \quad 97.842 \text{ MG}}$$

* Extraction Rate needed after reaching leachate maintenance level, Q_{ML}

$$Q_{ML} = V_{LP} = (2{,}769{,}545 \text{ gal/yr}) \times (1 \text{ yr} / 525{,}600 \text{ min})$$

$$\boxed{Q_{ML} = \quad 5.27 \text{ gpm} = 5.25 \text{ gpm}}$$

Will the leachate maintenance level of **756.57 ft** cause dry bottoming of either the old or new landfill areas?

(Refer to attached supporting information from RI Report.)

* Spot check boring data from both sides of the landfill to determine bottom elevations. (Selected locations are highlighted on the attached figure.)

* Ground elevation - depth to base material = Bottom Elevation

OLD LF				
LP2:	785.5 ft	- 40 ft	=	745.5 ft
LP3:	778.1 ft	- 28.5 ft	=	749.6 ft
LP12:	782.6 ft	- 25.5 ft	=	757.1 ft dry bot.
LP13:	779 ft	- 17 ft	=	762 ft dry bot.
LP11:	787.8 ft	- 33 ft	=	754.8 ft
LP4:	788.9 ft	- 40 ft	=	748.9 ft
B3:	773.7 ft	- 10.5 ft	=	763.2 ft dry bot.
LP2:	785.5 ft	- 40 ft	=	745.5 ft
NEW LF (deeper than OLD LF)				
LP5:	796.6 ft	- 51 ft	=	745.6 ft
GWF12:	792.5 ft	- 22+ ft	-->	770.5 INCONCLUSIVE
LP6:	794.6 ft	- 40 ft	=	754.6 ft
LP7:	794.7 ft	- 62 ft	=	732.7 ft
LP9:	785.5 ft	- 68.5 ft	=	717 ft

Leachate maintenance level of 756.57 ft would cause some amount of localized bottom drying near perimeter of old LF, but overall would not result in dry-bottoming of either the old or new landfills.

Groundwater Monitoring Costs

Objective: Determine costs for groundwater monitoring.

Quarterly Sampling: Assume sampling of 40 wells	
Labor, 40 wells*(1d/8 wells)*(8hr/d)*($62/hr*2)*4/yr =	$19,840
Travel Expenses, (5d * $40/d + $40)*4/yr =	$960
Equipment/Supplies, assume 4*$700 =	$2,800
Laboratory Analysis of Samples: Assume $350/well	
$375/well * 40 wells * 4/yr =	$60,000
Quarterly Reporting	
Data Prep, ($62/hr * 8hrs)*4 =	$1,984
CAD/Admin, ($44/hr * 8hrs)*4 =	$1,408
Report Writing/Data Interpritation ($74/hr * 24)*4 =	$7,104
QA/QC ($92/hr * 4hrs) *4 =	$1,472
TOTAL:	$95,600
Present Worth (5%, 30yrs) :	$1,469,600

RA2 - Abandon and replace VW4

Well Abandonment Cost

Engineering/Consulting ($74/hr * 40hrs + $92/hr*20hrs)=	$4,800
CAD/Administrative Support ($54/hr*20h + $44/hr*20h) =	$1,960
Bid-phase costs (Assume $7,500)	$7,500
Mobilization/Demobilization/Labor ($2,500 + $50/hr*2*50) =	$7,500
Misc. material/subconsulting costs (Assume $10,000)=	$10,000
Letter Report/Agency Communication ($74/hr*20hr + $92/hr * 10 hr)=	$2,400
Assume a 20% contingency factor :	$6,900
SUBTOTAL:	$41,100

Well Replacement Cost

See attached cost information.

Property purchase	$7,040
Well replacement	$76,012
Additional field investigation assistance	$1,355
Well production	$77,963
Well hook-up (includes capital & commodity charges)	$490,356
SUBTOTAL:	$652,800